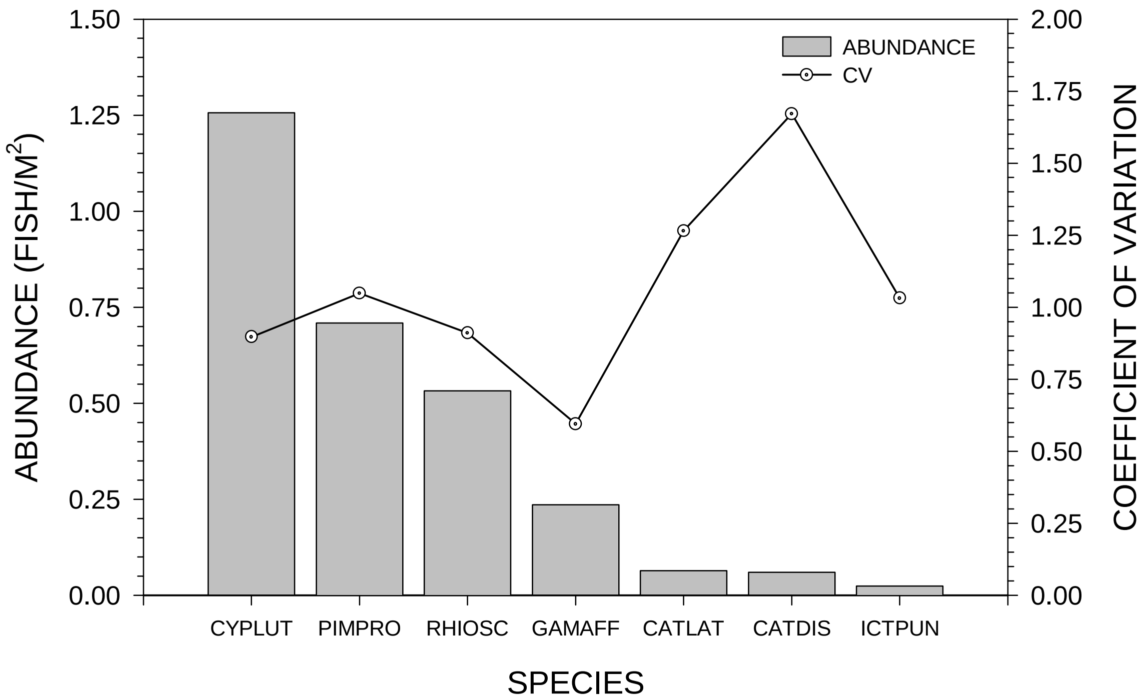
SMALL-BODIED FISH MONITORING

SAN JUAN RIVER

1998 AND 1999



David L. Propst, Amber L. Hobbes, and Robert D. Larson

Conservation Services Division

New Mexico Department of Game and Fish

Santa Fe, New Mexico

SAN JUAN RECOVERY IMPLEMENTATION PROGRAM

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INTRODUCTION

With completion of the Seven Year San Juan River Research Program in 1997, autumn monitoring of San Juan River fish communities was initiated in 1998. At that time, monitoring protocols were not developed. Thus, monitoring in 1998 basically followed procedures used during 1991 through 1997 to characterize San Juan River fish assemblages. Monitoring in 1999 followed procedures that were detailed in the draft San Juan River Monitoring Plan and Protocols. Because the protocols had not been finalized, one purpose of the 1999 effort was to evaluate the efficacy of draft protocols and use the experience of 1999 to recommend modifications to the draft monitoring protocols.

Seasonal characterization of fish assemblages of San Juan River secondary channels was an integral component of the Seven –Year Research Program. During spring, most fishes captured in secondary channels were large-bodied individuals, in summer and autumn secondary channels had mainly small-bodied fishes (Propst and Hobbes, 2000). Raft-mounted electrofishing gear was used for spring sampling and seines were used to obtain fishes in summer and autumn. No specific effort was made to characterize small-bodied fish assemblages of primary channel shoreline habitats. Raft-mounted electrofishing gear, used to sample primary channel fish assemblages during spring and autumn, was selective for large-bodied fishes; thus, capture of small-bodied fishes was incidental to the effort. Recognizing this deficit, the San Juan Recovery Implementation Program Biology Committee added shoreline sampling with seines to the monitoring protocol.

Data reported herein were collected from primary channel shoreline habitats and secondary channels during 1998 and 1999 autumn monitoring efforts. Secondary channel data from autumn inventories from 1993 through 1997 are included.

METHODS

Autumn sampling of small-bodied fishes in the San Juan River primary and secondary channels in 1998 was conducted from Shiprock, New Mexico (RM 149) to Chinle Creek, Utah (RM 68). All secondary channels having surface water were sampled. The primary channel was sampled at each sampled secondary channel or at 3-mile intervals if no secondary channels were present for 3 miles. In autumn 1999, the sampling protocol detailed in the draft San Juan River Monitoring Plan and Protocols was followed. Sampling began at the confluence of Animas and San Juan rivers (Reach 6, RM 180) and continued to Clay Hills Crossing (Reach 1, RM 3). From about Chinle Creek downstream, there are no secondary channels. Primary and secondary channel sampling occurred in 3-mile increments. If a secondary channel was not within the designated sample-mile, there was no secondary channel data collected for that 3-mile segment.

Primary and secondary channel sampling followed the methods detailed in the San Juan River Monitoring Plan and Protocol (Propst, et al., 2000) in both years. Seines (3.05 x 1.83 m, 3.2 mm mesh) were used to collect fish from mesohabitats. Collections were separated by mesohabitat. All mesohabitat types (see Bliesner and Lamarra, 2000) in a secondary channel and along primary channel shoreline were sampled in approximate proportion to their availability. After each seine haul, the collection was visually inspected to determine if protected species were captured. If protected species were found, they were weighed, measured, and released. All other specimens were preserved in 10% formalin and returned to laboratory. Collections were segregated by mesohabitat; specimens from each mesohabitat were preserved separately and uniquely numbered. Length and width of sampled area of each mesohabitat were marked by surveyor flags. After specimen collection, dimensions of each sampled area were measured. Water quality parameters (water temperature, dissolved oxygen, and specific conductance) were measured where secondary and primary channel fish collections were made. All pertinent data was recorded on standard forms.

Retained specimens were identified and enumerated in the laboratory. Standard length of largest and smallest specimen from each collection was determined. Identification of retained protected species was verified by personnel of UNM MSB, Division of Fishes. All retained specimens were accessioned to NMGF Collection of Fishes. Electronic copies of both years collections were provided to Keller-Bliesner Engineering for inclusion in the San Juan River datatbase.

Attributes of spring and summer discharge were derived from USGS Water Resources Data, New Mexico (USGS 1993 et seq.). Shiprock gage (#09368000) data were used for all calculations. Species abundance data were segregated by Geomorphic Reach (Bliesner and Lamarra, 2000). Shannon-Wiener Diversity Index values were calculated for each Geomorphic Reach. Abundance of each species was calculated as number of fish per m^2. Linear regression analysis was used to compare spring and summer discharge attributes to abundance of commonly collected species. Data from 1993 through 1999 were used in these comparisons.

RESULTS

DISCHARGE

In 1998, spring runoff began in late April and elevated flows extended through mid June (Figure 1). In 1999, spring runoff began about 3 weeks later than in 1998 and continued through mid July. Spring runoff (1 March through 31 July) during 1998 averaged 2690 cfs and was only slightly greater in 1999 (2793 cfs); spring discharge volume was likewise very similar (Table 1). Despite beginning at different dates, spring runoff peaked at the same time each year (early June). In 1998, base summer flows (< 1000 cfs) were reached in late July and, except for three flow spikes, remained < 1000 cfs through September. Summer flows in 1999 were never < 2500 cfs, were > 4000 cfs during August, and were >2500 cfs during September. Mean discharge during summer (1 July through 30 September) was 1089 cfs in 1998 and 4333 cfs in 1999 (Table 2). Discharge at time of sampling averaged 1039 cfs (range = 474 to 2080 cfs) in 1998 (29 September through 7 October) and in 1999 (20 September through 7 October).

WATER QUALITY

During autumn surveys in 1998, water temperature of primary and secondary channels generally declined in a downstream direction (Figure 2). In 1999, primary channel water temperature increased slightly in a downstream direction, but secondary

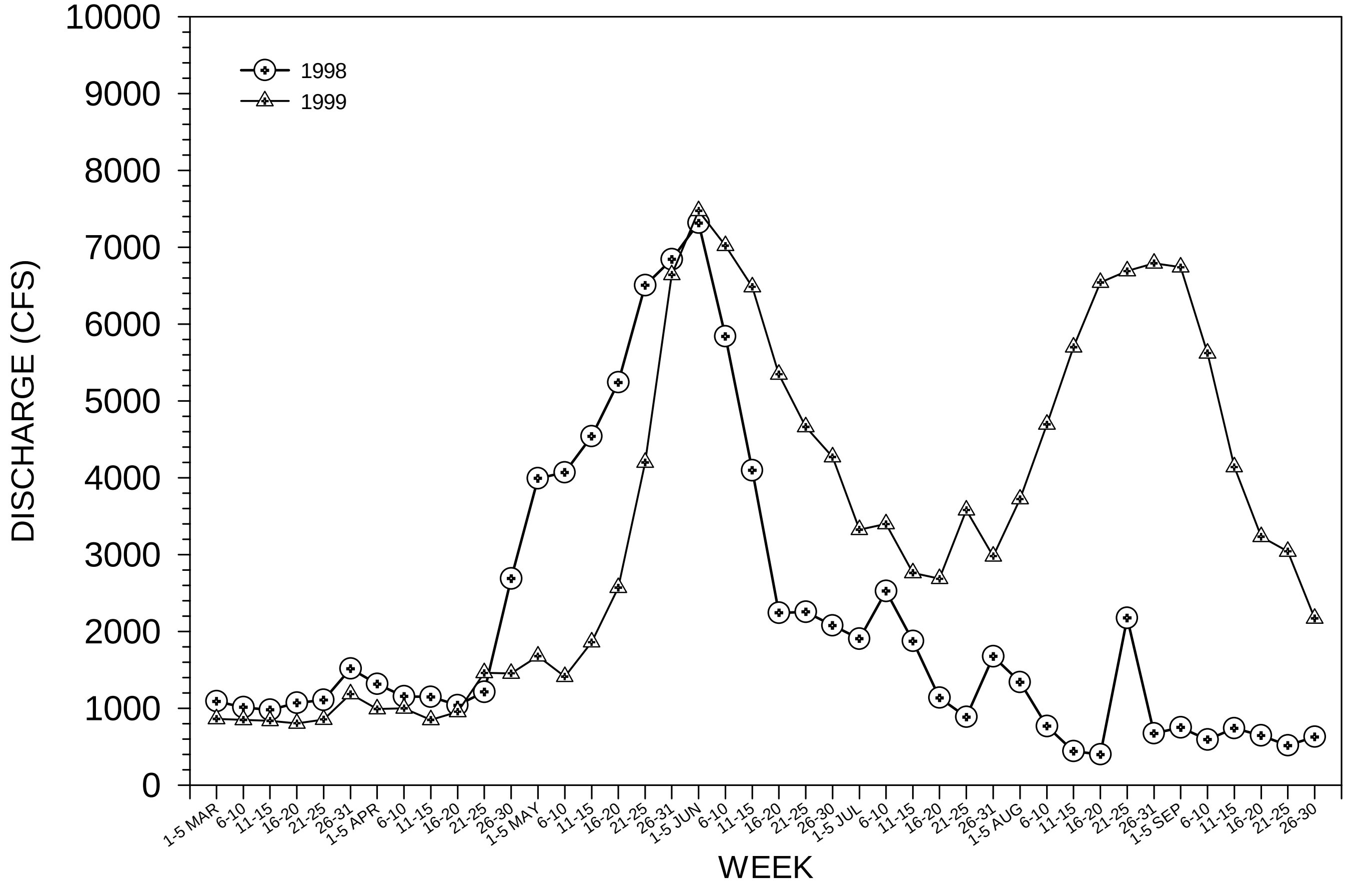

Figure 1. Mean weekly discharge (cfs) of San Juan River at Shiprock, New Mexico USGS gage, 1998 - 1999.

Table 1. Attributes of spring discharge, San Juan River, 1993 – 1999. Data from USGS Shiprock gage (#09368000).

	YEAR						
MONTH	1993	1994	1995	1996	1997	1998	1999
MARCH	5099	886	2777	700	2057	1141	869
APRIL	5970	868	3472	532	2295	1425	1087
MAY	6387	4779	6108	1997	5703	5250	3175
JUNE	6816	6563	9351	2661	8286	3970	5716
JULY	2438	3000	7193	789	3249	1665	3116
MEAN (CSF)	6646	3592	5440	1607	4805	2690	2793
VOLUME (AC-FT)	1,539,529	790,550	1,523,378	355,850	1,203,366	816,440	845,066
DAYS > 3000 CFS	126	62	109	16	75	48	58
DAYS > 5000 CFS	101	43	72	0	44	24	26
DAYS > 8000 CFS	11	7	27	0	24	0	0

Table 2. Attributes of summer discharge, San Juan River, 1993 – 1999. Data from USGS Shiprock gage (#09368000).

	YEAR						
MONTH	1993	1994	1995	1996	1997	1998	1999
JULY	922	1020	3282	563	2164	1665	3116
AUGUST	1346	534	1561	491	2306	959	5725
SEPTEMBER	1432	1078	1193	891	2361	644	4157
MEAN DISCHARGE (CFS)	1518	1271	2660	697	2524	1089	4333
DISCHARGE VOLUME (AC-FT)	197228	129298	271127	101116	350970	199660	790982
DISCHARGE SPIKE DATA							
DAYS > 5000 CFS	0	0	0	0	4	0	31
DAYS > 4000 CFS	3	0	0	0	7	1	42
DAYS > 3000 CFS	4	0	0	0	18	1	71
DAYS > 2000 CFS	10	2	13	0	30	11	89
DAYS > 1000 CFS	35	15	53	22	66	37	92
DAYS < 1000 CFS	37	54	13	55	7	55	0
DAYS < 750 CFS	35	42	0	69	3	42	0
DAYS < 500 CFS	0	20	0	39	0	15	0
NUMBER DISCHARGE SPIKES	4	3	3	5	3	4	1
SPIKE DURATION (DAYS)	35	15	29	22	66	37	92
SPIKE MEAN (CFS)	1878	1437	1589	1253	2479	1802	4333
SPIKE VOLUME (AC-FT)	130362	42740	91392	54680	324468	132220	790982

water temperature did not (Figure 2). With the exception of three secondary channels, dissolved oxygen of primary and secondary channels was very similar (Figure 3) and increased slightly in a downstream direction. In 1999, dissolved oxygen of primary and secondary channels did not change appreciably in the sampled reach (Figure 3). Specific conductance was variable among sites, particularly secondary channel sites, in 1998, but generally was similar throughout the study reach (Figure 4). In 1999, there was less variability, but an upward trend in specific conductance in a downstream direction. Differences between primary and secondary channels in mean water temperature and mean dissolved oxygen in 1998 and 1999 were negligible (Table 3). Mean specific conductance of primary and secondary channels in 1998 was substantially higher than in 1999.

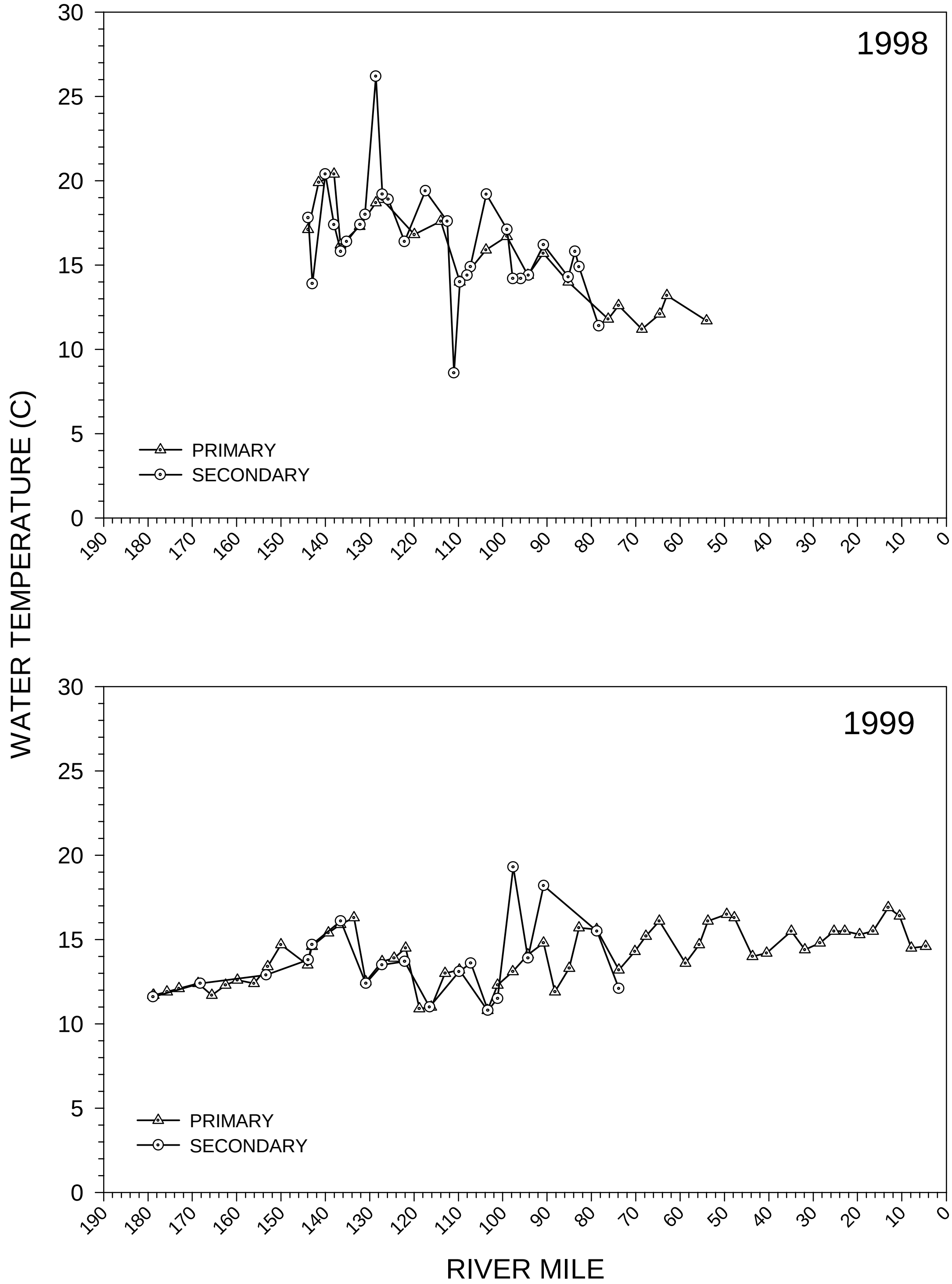

Figure 2. Water temperature of San Juan River secondary and primary channels during autumn inventories, 1993 - 1999.

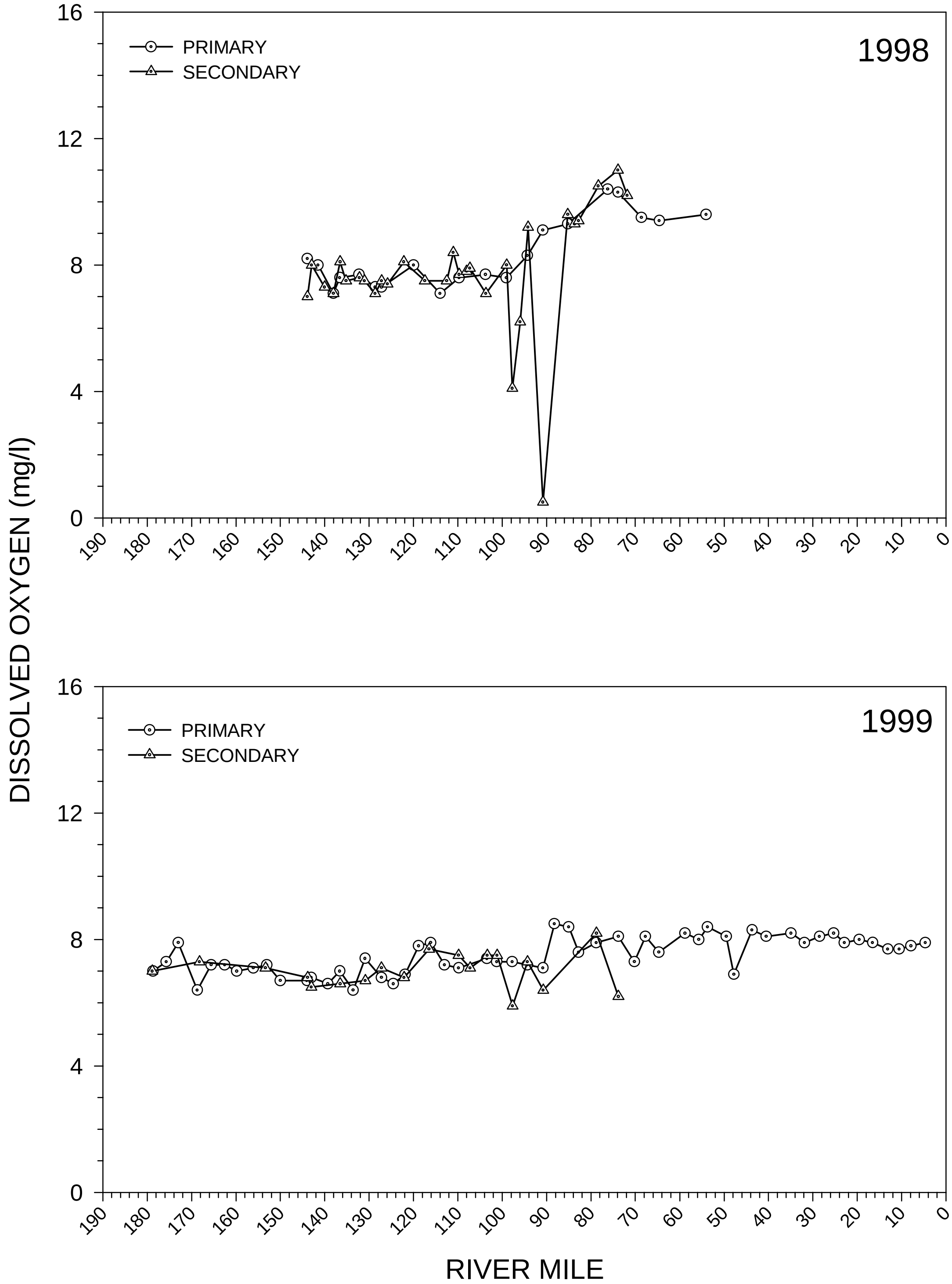

Figure 3. Dissolved oxygen (mg/l) of San Juan River secondary and primary channels during autumn inventories, 1993 - 1999.

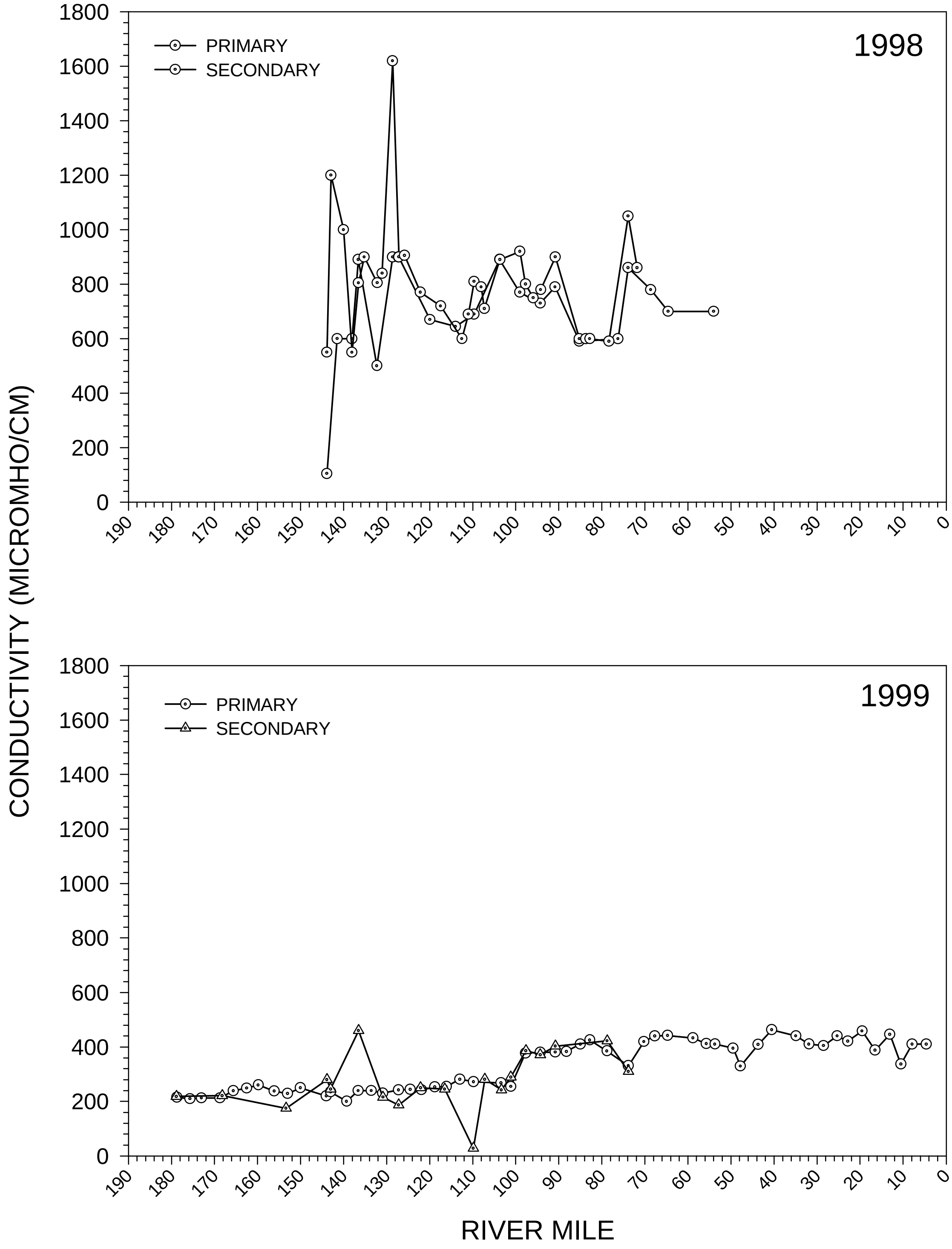

Figure 4. Conductivity (micromho/cm) of San Juan River secondary and primary channels during autumn inventories, 1993 - 1999.

Table 3. Mean values of water quality parameters of San Juan River primary and secondary channels during autumn inventories, 1993 – 1999. Values in parentheses are standard deviations.

	WATER TEMPERATURE (°C)		DISSOLVED OXYGEN (mg/l)		CONDUCTIVITY (μmho/cm)	
YEAR	1°	2°	1°	2°	1°	2°
1993	15.9 (1.6)	16.3 (2.0)	10.3 (1.1)	10.1 (1.1)	633 (109)	661 (121)
1994	13.8 (1.3)	14.2 (1.7)	11.6 (1.8)	11.6 (2.1)	643 (110)	676 (145)
1995	12.5 (1.4)	13.0 (2.4)	7.6 (1.3)	7.8 (1.2)	424 (56)	459 (130)
1996	9.8 (2.2)	10.2 (2.4)	9.9 (0.9)	10.0 (1.3)	411 (40)	445 (106)
1997	17.8 (1.2)	18.2 (1.7)	6.7 (0.3)	6.7 (0.7)	417 (57)	430 (114)
1998	15.5 (2.8)	16.3 (3.1)	8.4 (1.0)	7.7 (1.9)	696 (179)	817 (216)
1999	14.0 (1.6)	13.9 (2.3)	7.5 (0.6)	6.9 (0.6)	326 (89)	275 (99)

PRIMARY CHANNEL FISHES

Six native, seven nonnative, and one hybrid species were collected during primary channel small-bodied fish sampling efforts in 1998 and 1999 (Table 4). Roundtail chub was found in both years, but Colorado pikeminnow was collected only in 1998. One mottled sculpin, a native species, was collected in Reach 6 in 1999. Common carp and green sunfish, nonnative species, were collected only in 1999. Diversity (H) and total abundance was usually less in 1999 than 1998 (Figures 5 and 6). In Reach 5 diversity was almost the same in each year. Abundance varied among reaches in both years, but diversity declined from upstream to downstream.

Overall, red shiner and speckled dace were the first- and second-most commonly collected species in primary channel habitats in both years (Table 5). Channel catfish

Table 4. Occurrence of small-bodied fishes in San Juan River primary channel during autumn, 1998 – 1999. I = introduced and N = native. Six-letter code derived from first three letters of genus and second three from species.

COMMON	SCIENTIFIC	CODE	STATUS	1998	1999
Common carp	*Cyprinus carpio*	CYPCAR	I		X
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X
Roundtail chub	*Gila robusta*	GILROB	N	X	X
Fathead minnow	*Pimephales promelas*	PIMPRO	I	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N	X	
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X
Flannelmouth x bluehead	*C. latipinnis* x *C. discobolus*	LATDIS			X
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X
Plains killifish	*Fundulus zebrinus*	FUNZEB	I	X	
Western mosquitofish	*Gambusia affinis*	GAMAFF	I	X	
Green sunfish	*Lepomis cyanellus*	LEPCYA	I		X
Mottled sculpin	*Cottus bairdi*	COTBAI	N		X
TOTAL NATIVE			6	5	5
TOTAL NONNATIVE			7	5	5

was third-most common in 1998, but was rare in 1999. Total abundance declined from 0.81 fish/m^2 in 1998 to 0.30 fish/m^2.

Geomorphic Reach 6

Six fish species, three native and three nonnative, were collected in Reach 6 during 1999 autumn monitoring (Table 6). Speckled dace was the most common species. Assemblage diversity was low (H = 0.5347).

Geomorphic Reach 5

Four native and four nonnative fish species were collected in Reach 5 during autumn 1998; in 1999, three native and four nonnative fish species were collected (Table

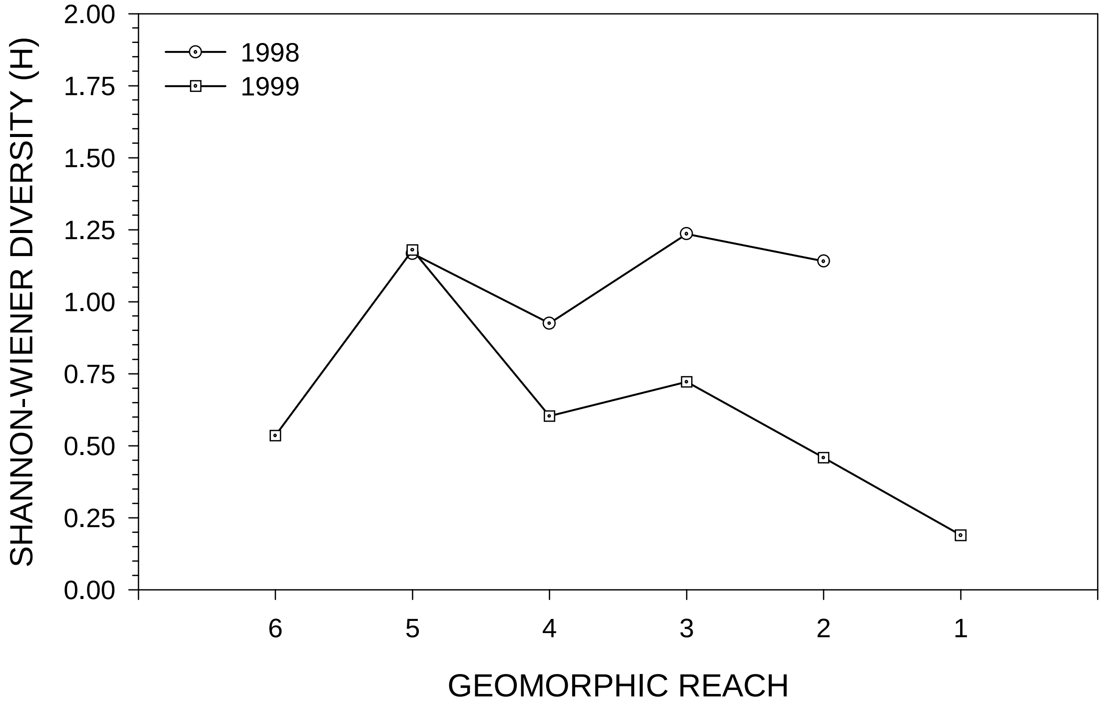

Figure 5. Shannon-Wiener Diversity (H) of fish assemblages in San Juan River primary channels during autumn surveys, 1998-1999.

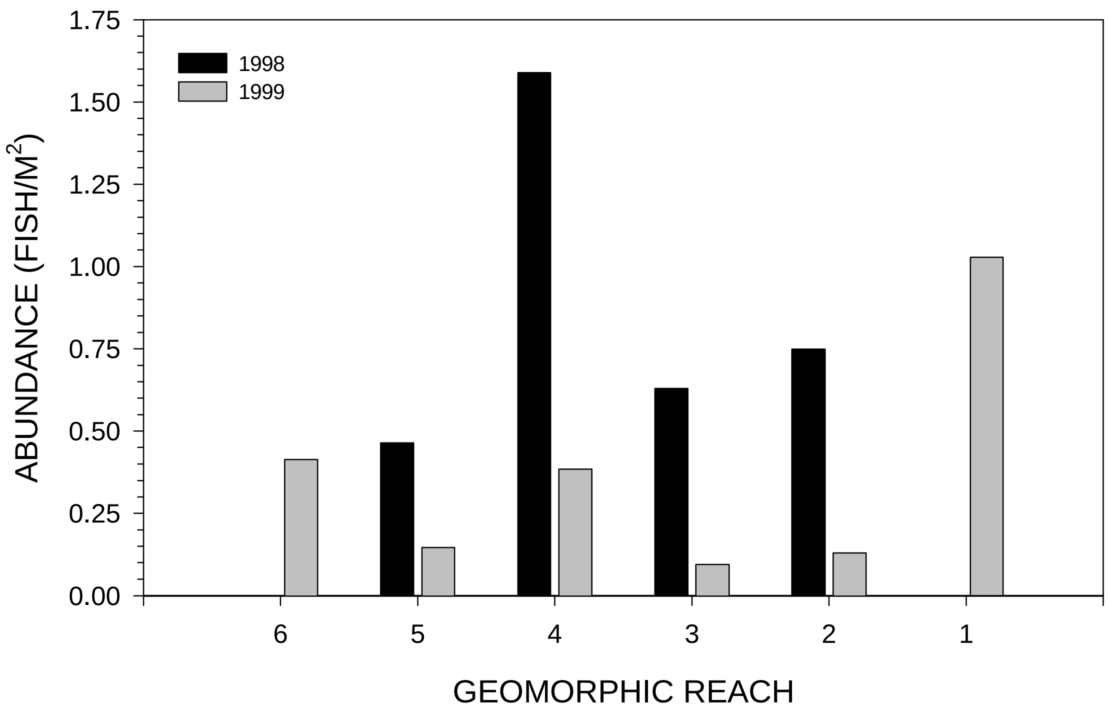

Figure 6. Abundance (fish/m^2) of fishes in San Juan River primary channel during autumn surveys, 1998 - 1999.

Table 5. Fishes collected in San Juan River primary channel during autumn, 1998 – 1999. Collections in 1998 from Geomorphic Reaches 5 through 2 and 1999 collections from Geomorphic Reaches 6 through 1.

1998		1999	
SPECIES	N	SPECIES	N
CYPLUT	592	CYPLUT	1071
RHIOSC	464	RHIOSC	335
ICTPUN	189	PIMPRO	48
PIMPRO	32	CATLAT	8
CATLAT	7	ICTPUN	7
PTYLUC	4	CATDIS	3
CATDIS	3	CYPCAR	1
GAMAFF	2	GILROB	1
GILROB	1	LAT x DIS	1
FUNZEB	1		
LEPCYA	1		
COTBAI	1		
TOTAL N	1297		1475
TOTAL AREA	1601		4883
ABUNDANCE	0.8101		0.3021

Table 6. Number and abundance (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 6 during autumn, 1999.

SPECIES	N	ABUNDANCE
RHIOSC	202	0.361
PIMPRO	17	0.030
CYPLUT	7	0.013
CATLAT	4	0.007
COTBAI	1	0.002
LEPCYA	1	0.002
TOTAL N	232	
AREA	560	
ABUNDANCE	0.414	
H	0.5347	

7). Colorado pikeminnow (1 specimen) was found in 1998. Speckled dace was the most-common and red shiner second-most common species in both years. Although abundance was considerably less in 1999 than 1998, assemblage diversity was similar between years.

Geomorphic Reach 4

Seven species were collected in Reach 4 in 1998, but only three were found (excluding one hybrid) in 1999 (Table 8). Total abundance of fishes was considerably greater in 1998 than 1999. Red shiner was most-common and speckled dace was second-most common in both years. Colorado pikeminnow and roundtail chub were found in 1998 (one specimen each), but only roundtail chub was found in 1999 (one specimen). Assemblage diversity was less in 1999 than 1998.

Geomorphic Reach 3

Eight fish species (four native and four nonnative) were collected in Reach 3 in 1998, and five (three native and two nonnative) were found in 1999 (Table 9). Speckled dace was the most-common species in 1998 and second-most common in 1999. In 1998, red shiner was second-most common, but most common in 1999. Two Colorado pikeminnows were collected in 1998, but none was found in 1999. Total abundance was considerably greater in 1998 than 1999. Assemblage diversity was considerably less in 1999 than 1998.

Table 7 . Number and abundance (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 5 during autumn, 1998 – 1999.

1998			1999		
SPECIES	N	ABUND	SPECIES	N	ABUND
RHIOSC	78	0.236	RHIOSC	47	0.083
CYPLUT	54	0.164	CYPLUT	24	0.042
ICTPUN	12	0.036	PIMPRO	4	0.007
PIMPRO	3	0.009	CATLAT	3	0.005
CATDIS	2	0.006	CATDIS	2	0.004
GAMAFF	2	0.006	ICTPUN	2	0.004
PTYLUC	1	0.003	CYPCAR	1	0.002
CATLAT	1	0.003			
TOTAL N	153			83	
AREA	330			568	
ABUND	0.464			0.146	
H	1.1669			1.1798	

Table 8. Number and abundance (number/m^2) of fishes in San Juan River primary channel in Geomorphic Reach 4 during autumn, 1998 – 1999.

1998			1999		
SPECIES	N	ABUND	SPECIES	N	ABUND
CYPLUT	343	1.075	CYPLUT	194	0.288
RHIOSC	108	0.339	RHIOSC	63	0.094
ICTPUN	40	0.125	GILROB	1	0.002
PIMPRO	13	0.041	LAT x DIS	1	0.002
CATLAT	1	0.003			
PTYLUC	1	0.003			
GILROB	1	0.003			
TOTAL N	507			259	
AREA	319			674	
ABUND	1.589			0.384	
H	0.9249			0.6032	

Table 9. Number and abundance (number/m^2) of fish in San Juan River primary channel in Geomorphic Reach 3 during autumn, 1998 - 1999.

1998			1999		
SPECIES	N	ABUND	SPECIES	N	ABUND
RHIOSC	197	0.304	CYPLUT	65	0.069
CYPLUT	97	0.150	RHIOSC	21	0.022
ICTPUN	94	0.145	PIMPRO	1	0.001
PIMPRO	12	0.019	CATLAT	1	0.001
CATLAT	4	0.006	CATDIS	1	0.001
PTYLUC	2	0.003			
CATDIS	1	0.002			
FUNZEB	1	0.002			
TOTAL N	408			89	
AREA	649			939	
ABUND	0.629			0.095	
H	1.2359			0.7216	

Geomorphic Reach 2

Two native and three nonnative fish species were collected in Reach 2 in 1998, but only one native, and three nonnative, species was found in 1999 (Table 10). Abundance rank of species did not change between years. Abundance in 1998 was substantially greater than in 1999; assemblage diversity was likewise greater in 1998 than 1999.

Geomorphic Reach 1

Four species (one native and three nonnative) were collected in Reach 1 in 1999 (Table 11). Red shiner was considerably more common than any other species. Assemblage diversity was low.

Table 10. Number and abundance (number/m^2) of fish in San Juan River primary channel in Geomorphic Reach 2 during autumn, 1998 – 1999.

	1998			1999	
SPECIES	N	ABUND	SPECIES	N	ABUND
CYPLUT	98	0.323	CYPLUT	173	0.113
RHIOSC	81	0.267	RHIOSC	16	0.011
ICTPUN	43	0.142	ICTPUN	4	0.003
PIMPRO	4	0.013	PIMPRO	3	0.002
CATLAT	1	0.003			
TOTAL N	227			196	
AREA	303			1525	
ABUND	0.749			0.129	
H	1.1406			0.4581	

Table 11. Number and abundance (number/m^2) of fish in San Juan River primary channel in Geomorphic Reach 1 during autumn, 1999.

SPECIES	N	ABUNDANCE
CYPLUT	608	0.982
PIMPRO	23	0.037
RHIOSC	2	0.003
ICTPUN	1	0.002
TOTAL N	634	
AREA	617	
ABUNDANCE	1.028	
H	0.1888	

Rare Fish Captures

Both Colorado pikeminnow and roundtail chub were collected in the primary channel in 1998, but only roundtail chub was collected from the primary channel in 1999. One specimen of Colorado pikeminnow was collected in each Reach 5 and 4 and two were collected in Reach 3. Roundtail chub was found in Reach 4 in both years.

Among Geomorphic Reach Comparisons

In 1998, assemblage diversity of small-bodied fishes was fairly similar among reaches and ranged between about 1.0 to 1.2, but in 1999 declined from Reach 5 (H = 1.2) through Reach 6 (H = 0.2; Figure 5). Total abundance of small-bodied fishes in the primary channel was substantially greater in Reach 3 than other sampled reaches in 1998 (Figure 6). In commonly sampled Reaches (5 through 2), total abundance was considerably less in 1999 than 1998. Total abundance was markedly greater in Reach 1 than other Reaches in 1999.

In 1998, abundance of red shiner was greatest in Reach 4, but was greatest in Reach 1 in 1999 (Figure 7a). In commonly sampled reaches (5 through 2), its abundance was less in 1999 than 1998. Speckled dace abundance was at least twice as great in 1998 than 1999 in commonly sampled reaches (Figure 7b). In 1999, speckled dace was most abundant in Reach 6 and least in Reach 1. Fathead minnow abundance was greatest in Reach 4 in 1998 (Figure 8a). In 1999, it was moderately common in Reaches 6 and 1 (not sampled in 1998), but absent or uncommon in Reaches 5 through 2. Between 1998 and 1999, channel catfish abundance declined dramatically (Figure 8b). It was absent in two reaches (4 and 3) in 1999 where it was comparatively common in 1998.

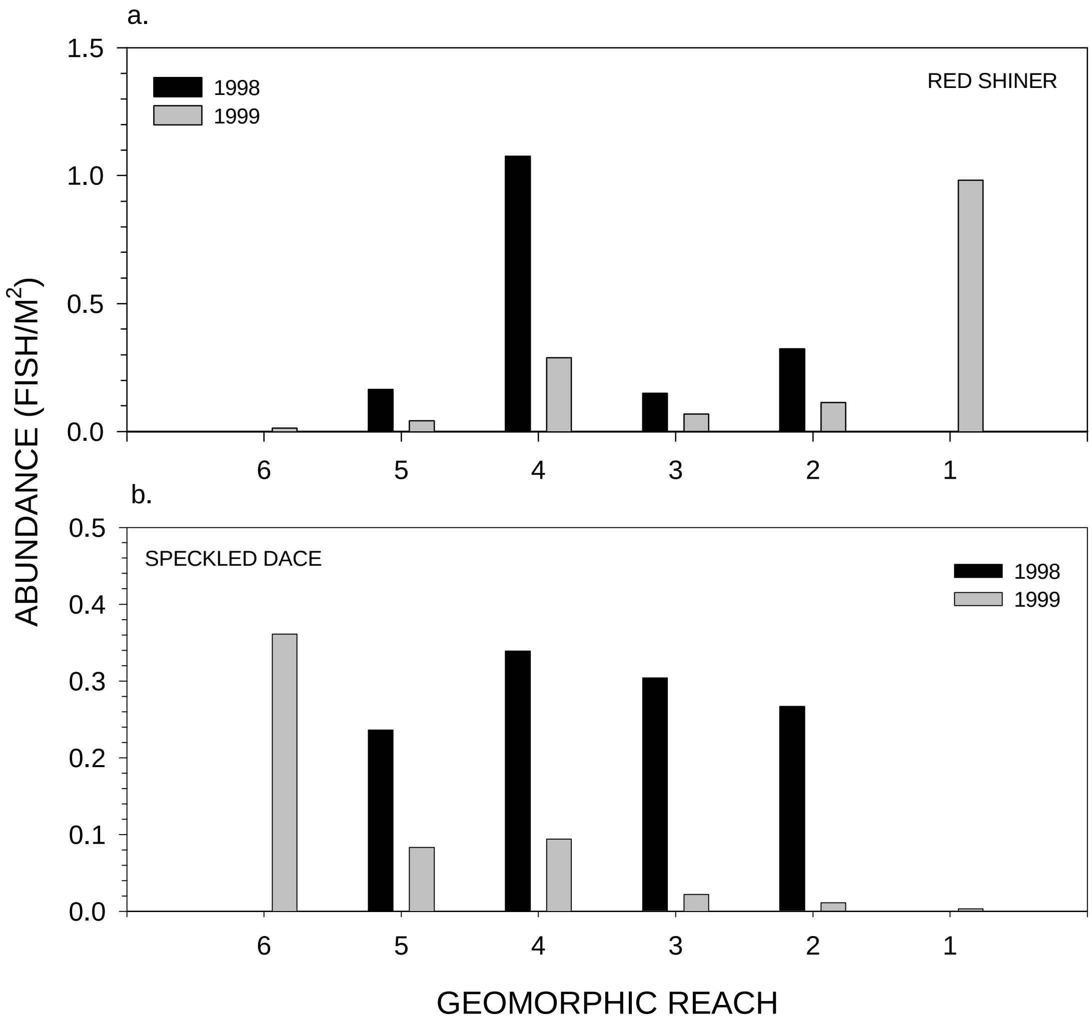

Figure 7. Abundance of red shiner and speckled dace in San Juan River primary channel during autumn, 1998 - 1999.

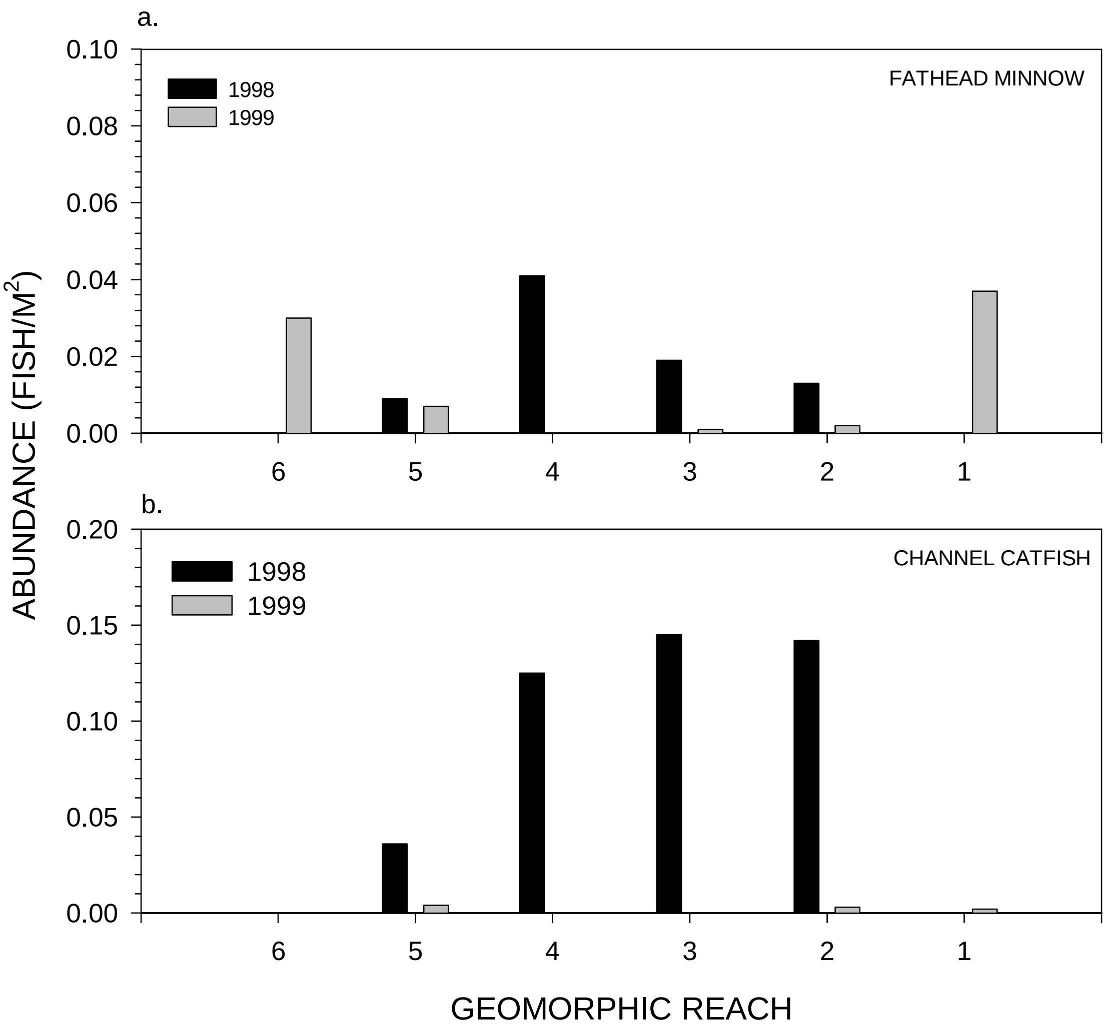

Figure 8. Abundance of fathead minnow and channel catfish in San Juan River primary channel during autumn, 1998 - 1999.

SECONDARY CHANNEL FISHES

In 1998, 14 fish species (five native and nine nonnative) were captured in San Juan River secondary channels and 11 (six native and five nonnative) were found in 1999 (Table 12). Roundtail chub and Colorado pikeminnow were found in both years.

Table 12. Occurrence of fishes in San Juan River secondary channels during autumn 1993 – 1999. I = introduced and N = native. Six-letter codes derived from first three letters of genus and first three letters of species. Data for 1993 – 1997 includes Geomorphic Reaches 5 through 3, 1998 also includes Reach 2, and 1999 includes Geomorphic Reaches 6 through 1.

COMMON	SCIENTIFIC	CODE	STATUS	1993	1994	1995	1996	1997	1998	1999
Common carp	*Cyprinus carpio*	CYPCAR	I	X	X	X	X	X	X	
Red shiner	*Cyprinella lutrensis*	CYPLUT	I	X	X	X	X	X	X	X
Roundtail chub	*Gila robusta*	GILROB	N					X	X	X
Fathead minnow	*Pimephales promelas*	PIMPRO	I	X	X	X	X	X	X	X
Colorado pikeminnow	*Ptychocheilus lucius*	PTYLUC	N					X	X	X
Speckled dace	*Rhinichthys osculus*	RHIOSC	N	X	X	X	X	X	X	X
Flannelmouth sucker	*Catostomus latipinnis*	CATLAT	N	X	X	X	X	X	X	X
Bluehead sucker	*Catostomus discobolus*	CATDIS	N	X	X	X	X	X	X	X
Black bullhead	*Ameiurus melas*	AMEMEL	I		X	X				
Yellow bullhead	*Ameiurus natalis*	AMENAT	I						X	
Channel catfish	*Ictalurus punctatus*	ICTPUN	I	X	X	X	X	X	X	X
Plains killifish	*Fundulus zebrinus*	FUNZEB	I	X	X	X	X	X	X	
Western mosquitofish	*Gambusia affinis*	GAMAFF	I	X	X	X	X	X	X	X
Green sunfish	*Lepomis cyanellus*	LEPCYA	I		X	X	X	X	X	X
Largemouth bass	*Micropterus salmoides*	MICSAL	I		X	X	X	X	X	
Mottled sculpin	*Cottus bairdi*	COTBAI	N							X
TOTAL NATIVE			10	3	3	3	3	5	5	6
TOTAL NONNATIVE			6	6	9	9	8	8	9	5

Mottled sculpin was collected in 1999. Total abundance of fishes was greater in 1998 than 1997, but abundance in 1999 was the lowest since autumn sampling of secondary channels began in 1993 (Table 13). Red shiner was the most-abundant species and speckled dace was second-most abundant in 1998 and 1999. Although assemblage diversity was lower in 1999 than it was in 1997 or 1998, it was not substantially lower than in 1993 through 1996 (Figure 9).

Geomorphic Reach 6

Two secondary channels were sampled in Reach 6 in 1999. Between them, only native speckled dace and mottled sculpin were collected. Speckled dace was moderately common (0.271/m^2), but only two specimens of mottled sculpin were found.

Table 13. Number of fishes collected in San Juan River secondary channels during autumn inventories, 1993 - 1999.

1993		1994		1995		1996		1997		1998		1999	
SPECIES	N	SPECIES	N	SPECIES	N	SPECIES	N	SPECIES	N	SPECIES	N	SPECIES	N
CYPLUT	2427	CYPLUT	5397	CYPLUT	4125	CYPLUT	3632	CYPLUT	1023	CYPLUT	741	CYPLUT	272
RHIOSC	1090	PIMPRO	2196	PIMPRO	2417	PIMPRO	2201	RHIOSC	564	RHIOSC	597	RHIOSC	115
PIMPRO	699	RHIOSC	967	RHIOSC	987	GAMAFF	716	PTYLUC	241	PIMPRO	162	PIMPRO	20
CATLAT	189	GAMAFF	643	GAMAFF	135	RHIOSC	127	PIMPRO	175	ICTPUN	138	CATDIS	4
CATDIS	164	ICTPUN	204	ICTPUN	62	ICTPUN	57	CATLAT	75	GAMAFF	113	CATLAT	4
ICTPUN	97	CATLAT	192	CATLAT	57	CATLAT	31	ICTPUN	68	CATLAT	13	ICTPUN	4
FUNZEB	65	FUNZEB	43	CATDIS	42	CATDIS	29	CATDIS	45	FUNZEB	4	GAMAFF	3
GAMAFF	45	CATDIS	20	FUNZEB	18	FUNZEB	17	CYPCAR	18	CYPCAR	2	COTBAI	2
CYPCAR	7	MICSAL	10	CYPCAR	9	CYPCAR	1	GAMAFF	15	GILROB	2	GILROB	1
		CYPCAR	8	LEPCYA	2	LEPCYA	1	GILROB	11	CATDIS	2	PTYLUC	1
		AMEMEL	3	MICSAL	1	MICSAL	1	FUNZEB	3	AMENAT	2	LEPCYA	1
		LEPCYA	1	AMEMEL	1			LEPCYA	1	PTYLUC	1		
								MICSAL	1	LEPCYA	1		
TOTAL N	4783		9684		7856		6813		2119		1778		427
AREA	1058		2456		1758		2715		2681		1904		1356
ABUND	4.521		3.943		4.469		2.509		0.7904		0.934		0.315
H	1.397		1.285		1.159		1.118		1.587		1.412		1.018

Geomorphic Reach 5

Twelve fish species were collected in Reach 5 in 1998 and eight were found in 1999 (Table 14). Red shiner and speckled dace were first- or second-most common in both years. In 1999, total abundance was about one-third that of 1998. One specimen of Colorado pikeminnow was found in each year. Abundance of fish in 1998 was less than in preceding years and that in 1999 was the lowest of the 7 years of record (Figure 10). From 1993 through 1999, red shiner had the greatest mean abundance and channel catfish the least in Reach 5 (Figure 11).

Geomorphic Reach 4

Among the 12 fish species collected in Reach 4 in 1998, four were comparatively common with red shiner being the most abundant (Table 15). Of the common fishes,

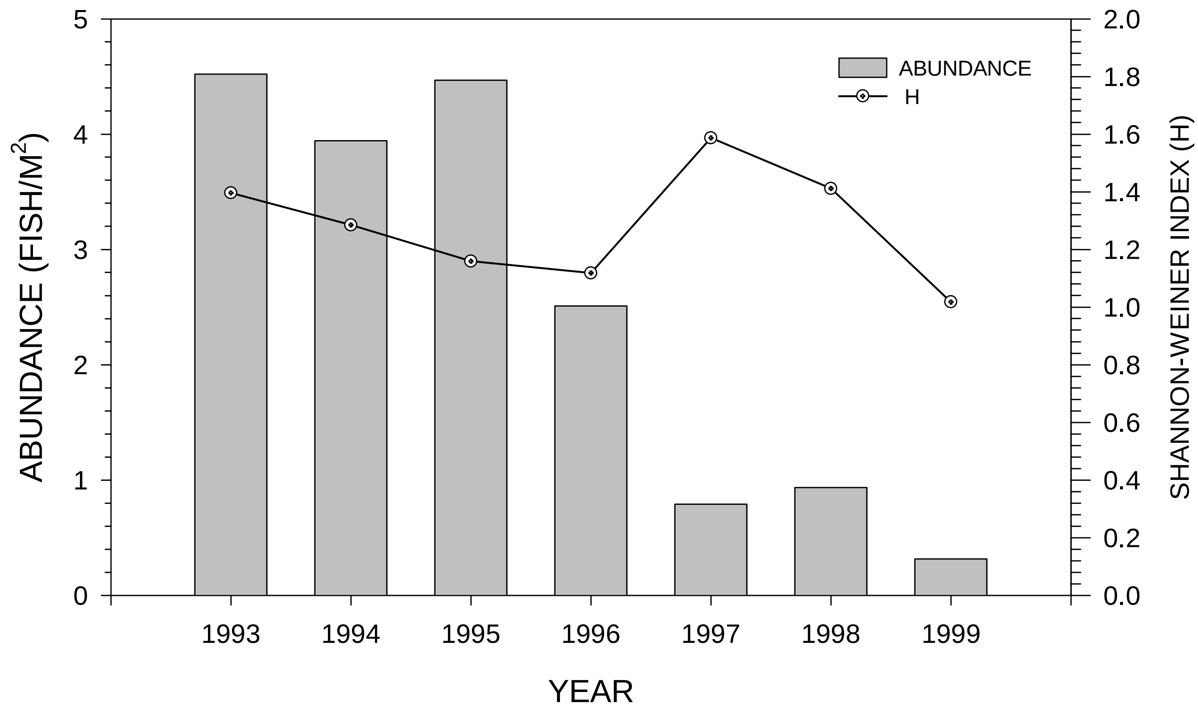

Figure 9. Abundance of fishes and Shannon-Weiner Diversity index values of fish assemblages in San Juan River secondary channels during autumn, 1993-1999.

Table 14. Number and abundance (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 5
(RM 154 – RM 131) during autumn 1993 – 1999.

1993			1994			1995			1996			1997		
Species	N	Abun	Species	N	Abun	Species	N	Abun	Species	N	Abun	Species	N	Abun
Cyplut	1028	2.62	Cyplut	1066	1.16	Cyplut	341	1.07	Cyplut	1626	2.99	Rhiosc	292	0.40
Pimpro	627	1.6	Pimpro	695	0.76	Rhiosc	305	0.95	Pimpro	1559	1.85	Cyplut	292	0.40
Rhiosc	545	1.39	Rhiosc	541	0.59	Pimpro	156	0.49	Gamaff	501	0.92	Ptyluc	192	0.26
Catdis	110	0.28	Gamaff	268	0.29	Gamaff	49	0.15	Rhiosc	63	0.12	Pimpro	114	0.15
Catlat	90	0.23	Ictpun	74	0.08	Catlat	35	0.11	Ictpun	13	0.02	Catlat	20	0.03
Gamaff	44	0.11	Catlat	50	0.05	Catdis	26	0.08	Funzeb	9	0.02	Ictpun	16	0.02
Funzeb	11	0.03	Funzeb	26	0.03	Cypcar	4	0.01	Catlat	6	0.01	Cypcar	16	0.02
Ictpun	6	0.02	Catdis	10	0.01	Ictpun	2	0.01	Catdis	4	0.01	Gamaff	13	0.02
Cypcar	3	0.01	Micsal	9	0.01	Lepcya	1	<0.01	Cypcar	1	<0.01	Catdis	12	0.02
			Cypcar	2	<0.01	Micsal	1	<0.01				Gilrob	2	<0.01
												Funzeb	2	<0.01
												Lepcya	1	<0.01
												Micsal	1	<0.01
Total N	2464			2741			920			3782			971	
Area	392			920			320			544			738	
Abun	6.286			2.979			2.875			6.952			1.316	
H	1.425			1.522			1.468			1.118			1.650	

1998			1999		
Species	N	Abun	Species	N	Abun
Cyplut	267	0.48	Rhiosc	37	0.09
Rhiosc	106	0.19	Cyplut	32	0.08
Gamaff	87	0.16	Pimpro	14	0.03
Pimpro	46	0.08	Catdis	2	0.01
Catlat	7	0.01	Catlat	2	0.01
Ictpun	4	0.01	Ptyluc	1	<0.01
Catdis	2	<0.01	Ictpun	1	<0.01
Cypcar	1	<0.01	Lepcya	1	<0.01
Ptyluc	1	<0.01			
Amenat	1	<0.01			
Funzeb	1	<0.01			
Lepcya	1	<0.01			
	384			90	
	559			419	
	0.687			0.215	
	1.354			1.342	

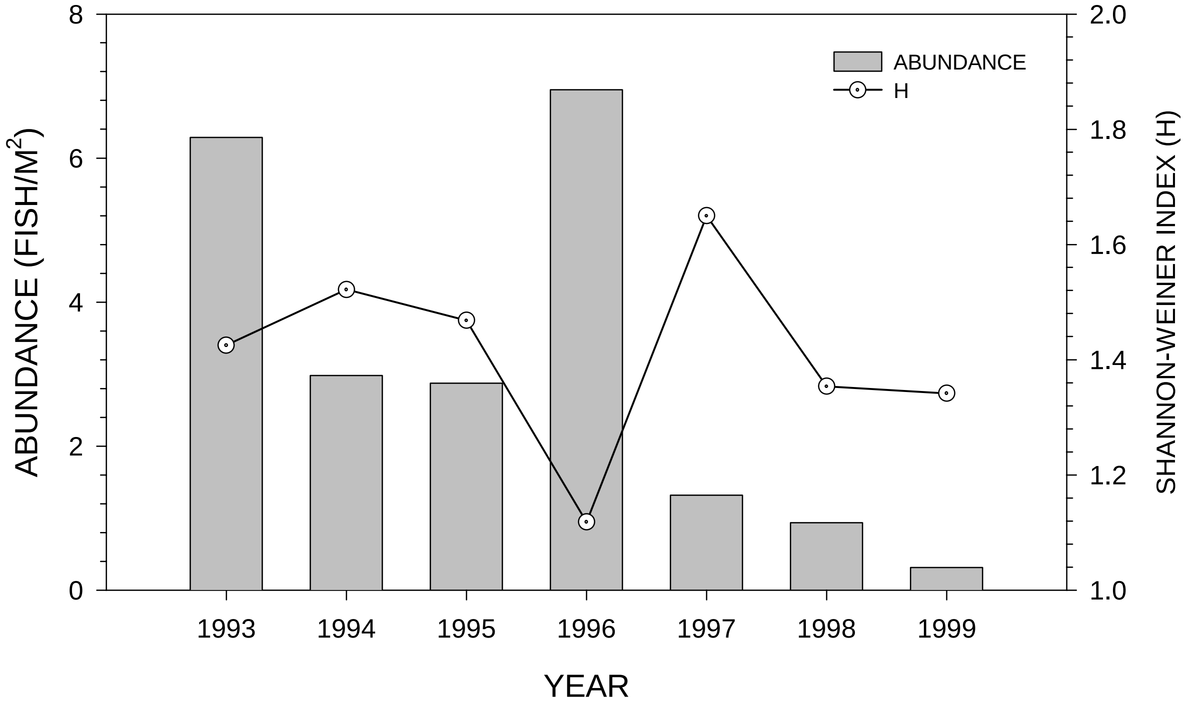

Figure 10. Abundance of fishes and Shannon-Weiner Diversity Index values of fish assemblages during autumn in Geomorphic Reach 5, San Juan River, 1993-1999.

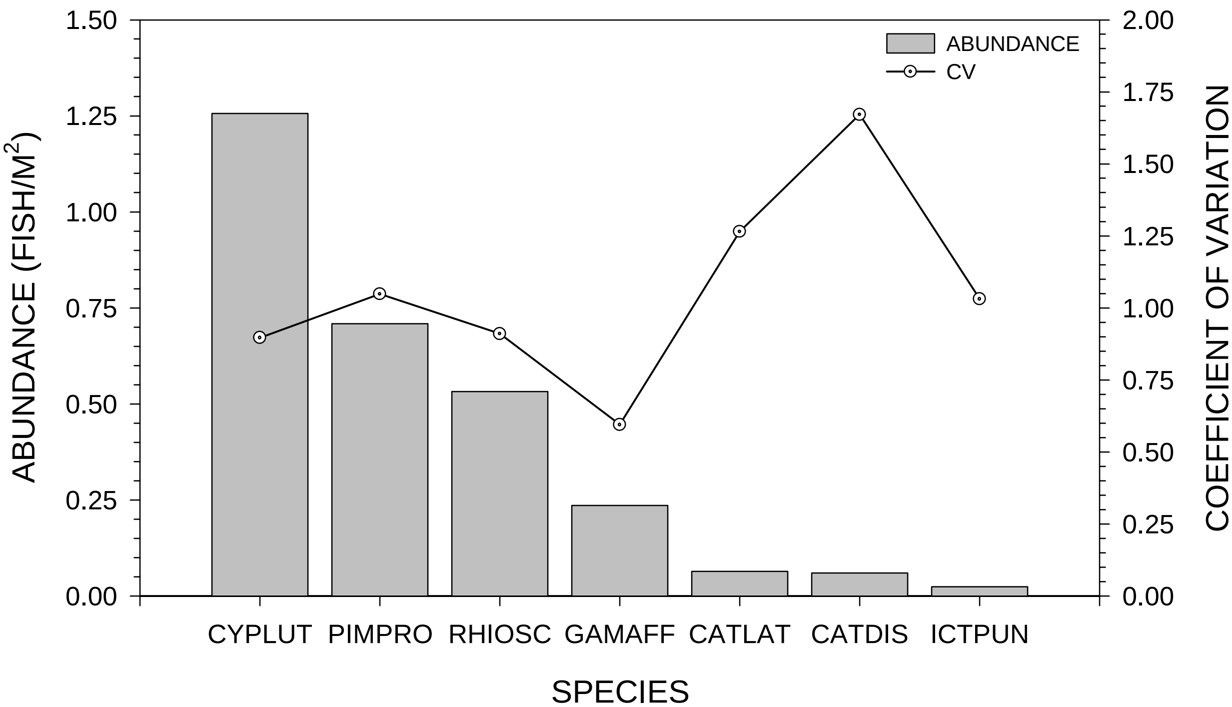

Figure 11. Mean abundance (fish/m^2) and coefficient of variation of abundance of fish species commonly collected during autumn in Geomorphic Reach 5, San Juan River, 1993 - 1999.

Table 15. Number and abundance (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 4 (RM 130 – RM 106) during autumn, 1993 – 1999.

1993			1994			1995			1996			1997		
Species	N	Abun	Species	N	Abun	Species	N	Abun	Species	N	Abun	Species	N	Abun
Cyplut	1084	2.34	Cyplut	1459	1.96	Cyplut	1340	1.51	Cyplut	1046	1.87	Cyplut	203	0.21
Rhiosc	472	1.02	Pimpro	657	0.88	Rhiosc	479	0.54	Pimpro	473	0.84	Rhiosc	114	0.12
Catlat	68	0.15	Rhiosc	164	0.22	Pimpro	220	0.25	Gamaff	188	0.34	Ictpun	20	0.02
Catdis	54	0.12	Gamaff	145	0.19	Gamaff	66	0.07	Rhiosc	37	0.07	Pimpro	14	0.01
Pimpro	45	0.10	Ictpun	50	0.07	Ictpun	34	0.04	Ictpun	25	0.05	Ptyluc	9	0.01
Ictpun	24	0.05	Catlat	20	0.03	Catlat	15	0.02	Catlat	4	0.01	Catlat	7	0.01
Funzeb	7	0.02	Funzeb	9	0.01	Catdis	6	0.01	Funzeb	3	0.01	Catdis	6	0.01
Gamaff	1	<0.01	Catdis	4	0.01	Cypcar	1	<0.01	Lepcya	1	<0.01	Gilrob	5	0.01
			Cypcar	4	0.01	Funzeb	1	<0.01	Micsal	1	<0.01	Cypcar	1	<0.01
			Amemel	1	<0.01							Gamaff	1	<0.01
			Lepcya	1	<0.01									
			Micsal	1	<0.01									
Total N	1755			2515			2162			1778			380	
Area	464			744			888			560			960	
Abun	3.782			3.380			2.435			3.175			0.396	
H	1.062			1.176			1.093			1.075			1.272	

1998			1999		
Species	N	Abun	Species	N	Abun
Cyplut	250	0.38	Cyplut	35	0.07
Rhiosc	119	0.18	Rhiosc	24	0.06
Ictpun	71	0.11	Ictpun	3	0.01
Pimpro	65	0.10	Pimpro	2	<0.01
Gamaff	7	0.01	Gilrob	1	<0.01
Gilrob	2	<0.01	Catdis	1	<0.01
Cypcar	1	<0.01			
Catlat	1	<0.01			
Funzeb	1	<0.01			
	517			66	
	664			418	
	0.778			0.156	

speckled dace was the only native species. In 1999, total abundance of fishes was considerable less than in 1998 and red shiner and speckled dace were the most common. Roundtail chub was collected in 1998 and 1999, but not Colorado pikeminnow were collected in either year. Total abundance was greater in 1998 than 1997, but that of 1999 was the least of the seven year record. Despite substantial changes in total abundance, assemblage diversity was fairly constant for all years of study (Figure 12). During the study (1993 – 1999), red shiner had the greatest mean abundance and fathead minnow and speckled dace were nearly equal (Figure 13). Flannelmouth sucker and bluehead sucker mean abundance was less than that of channel catfish.

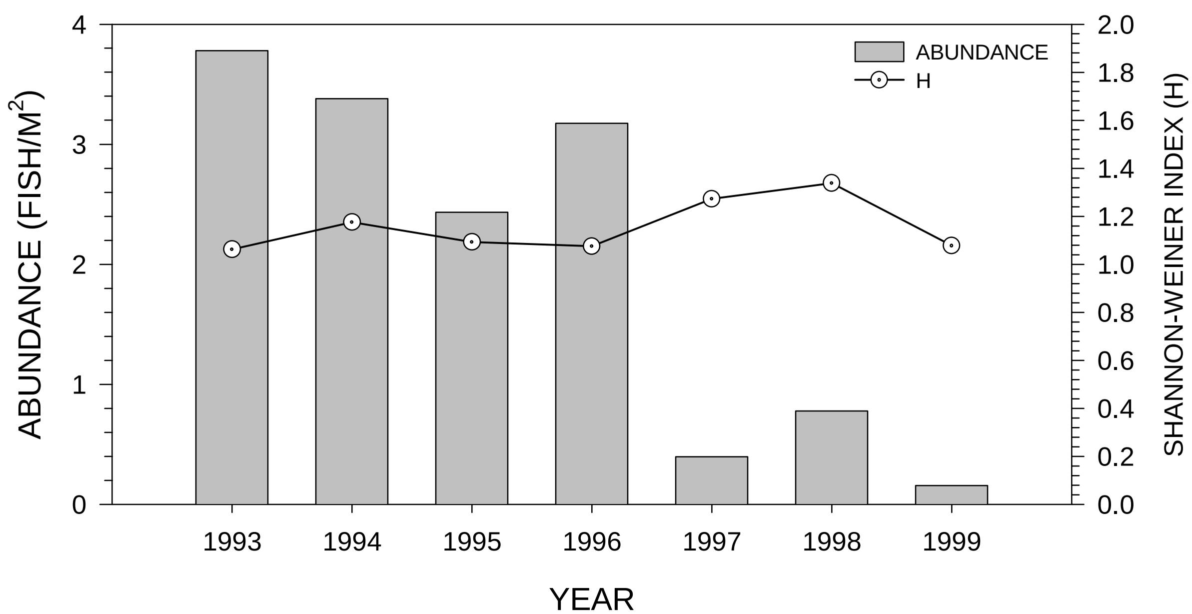

Figure 12. Abundance of fishes and Shannon-Weiner Diversity Index values of fish assemblages during autumn in Geomorphic Reach 4, San Juan River, 1993-1999.

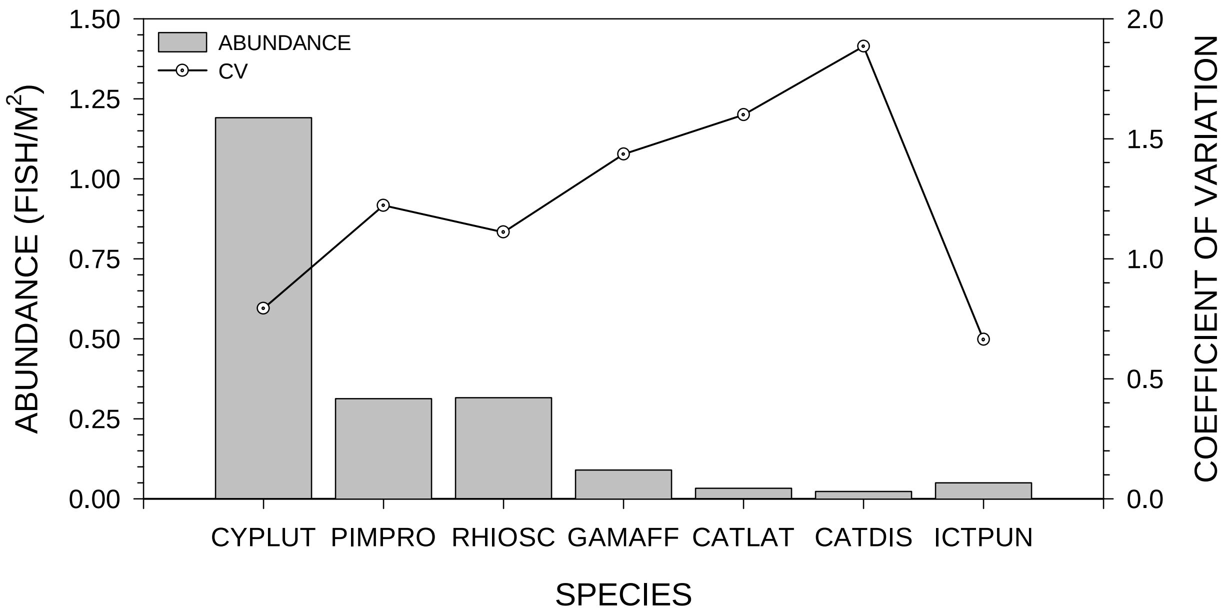

Figure 13. Mean abundance (fish/m^2) and coefficient of variation of abundance of fish species commonly collected during autumn in Geomorphic Reach 4, San Juan River, 1993 - 1999.

Geomorphic Reach 3

Speckled dace was the most-common of eight species collected in 1998 and red shiner was the most common of six species collected in 1999 (Table 16). Five species were comparatively common in 1998, but only two were in 1999. No Colorado pikeminnow nor roundtail chub was collected in either 1998 or 1999. Total abundance of fishes was slightly greater in 1998 than 1997 and abundance in 1999 was slightly less than 1997 (Figure 14). In 1998, assemblage diversity was greatest of the seven years study, but in 1999 was least. Between 1993 and 1999, mean abundance of channel catfish was greater than all other species except red shiner (Figure 15). Mean abundance of all native fish species was less than any nonnative species except western mosquitofish, and it was only less than speckled dace.

Table 16. Number and abundance (number/m^2) of fishes in San Juan River secondary channels in Geomorphic Reach 3 (RM 105 – RM 68) during autumn 1993 – 1997.

1993			1994			1995			1996			1997		
Species	N	Abun	Species	N	Abun	Species	N	Abun	Species	N	Abun	Species	N	Abun
Cyplut	315	1.58	Cyplut	2872	3.63	Cyplut	2444	4.44	Cyplut	960	1.69	Cyplut	527	0.54
Rhiosc	73	0.37	Pimpro	844	1.07	Pimpro	2041	3.71	Pimpro	169	0.30	Rhiosc	151	0.15
Ictpun	67	0.34	Rhiosc	262	0.33	Rhiosc	203	0.37	Rhiosc	27	0.05	Pimpro	47	0.08
Catlat	31	0.16	Gamaff	230	0.29	Ictpun	26	0.05	Gamaff	27	0.05	Ictpun	23	0.04
Pimpro	27	0.14	Catlat	122	0.15	Gamaff	20	0.04	Catlat	21	0.04	Ptyluc	13	0.02
Cypcar	4	0.02	Ictpun	80	0.10	Funzeb	17	0.03	Ictpun	19	0.03	Catlat	10	0.02
funzeb	2	0.01	Funzeb	8	0.01	Catdis	10	0.02	Catdis	7	0.01	Gilrob	4	0.01
			Catdis	6	0.01	Catlat	7	0.01	Funzeb	5	0.01	Catdis	2	<0.01
			Cypcar	2	<0.01	Cypcar	4	0.01				Cypcar	1	<0.01
			Amemel	2	<0.01	Amemel	1	<0.01				Funzeb	1	<0.01
						Lepcya	1	<0.01				Gamaff	1	<0.01
Total N	519			4428			4774			1235			780	
Area	200			792			550			568			983	
Abun	2.595			5.591			8.680			2.174			0.794	
H	1.224			1.117			0.943			0.820			1.048	

1998			1999		
Species	N	Abun	Species	N	Abun
Rhiosc	372	0.55	Cyplut	205	0.56
Cyplut	224	0.33	Rhiosc	32	0.09
Ictpun	63	0.09	Pimpro	4	0.01
Pimpro	51	0.08	Gamaff	3	0.01
Gamaff	19	0.03	Catlat	2	<0.01
Catlat	5	0.01	Catdis	1	<0.01
Funzeb	2	<0.01			
Amenat	1	<0.01			
	737			247	
	681			373	
	1.082			0.662	
	1.255			0.601	

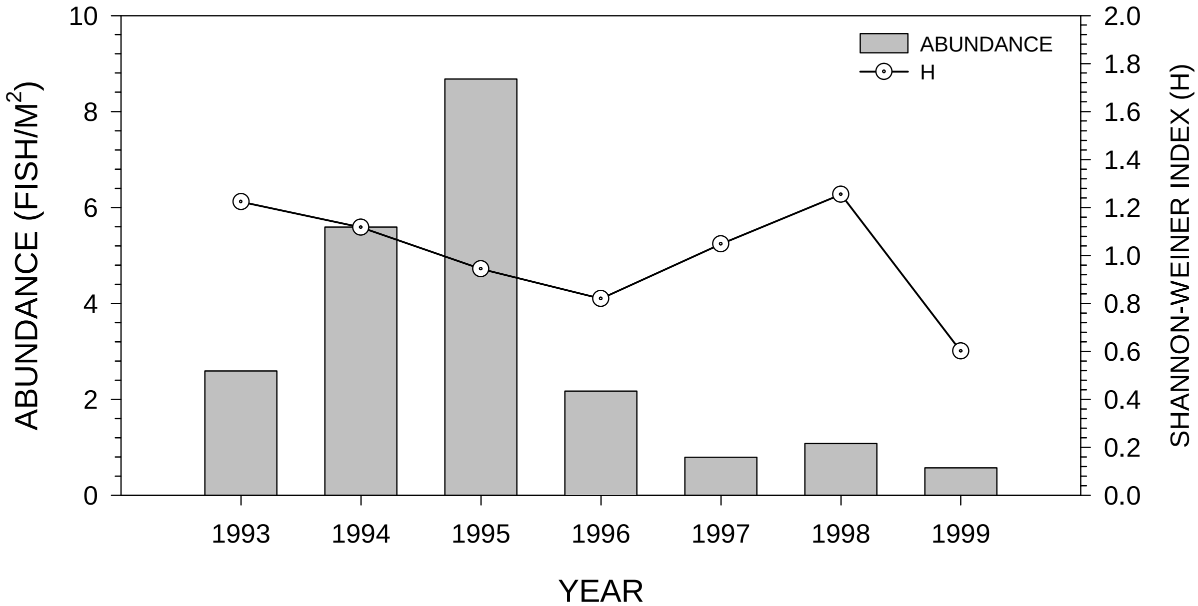

Figure 14. Abundance of fishes and Shannon-Weiner Diversity Index values for fish assemblages during autumn in Geomorphic Reach 3, San Juan River, 1993-1999.

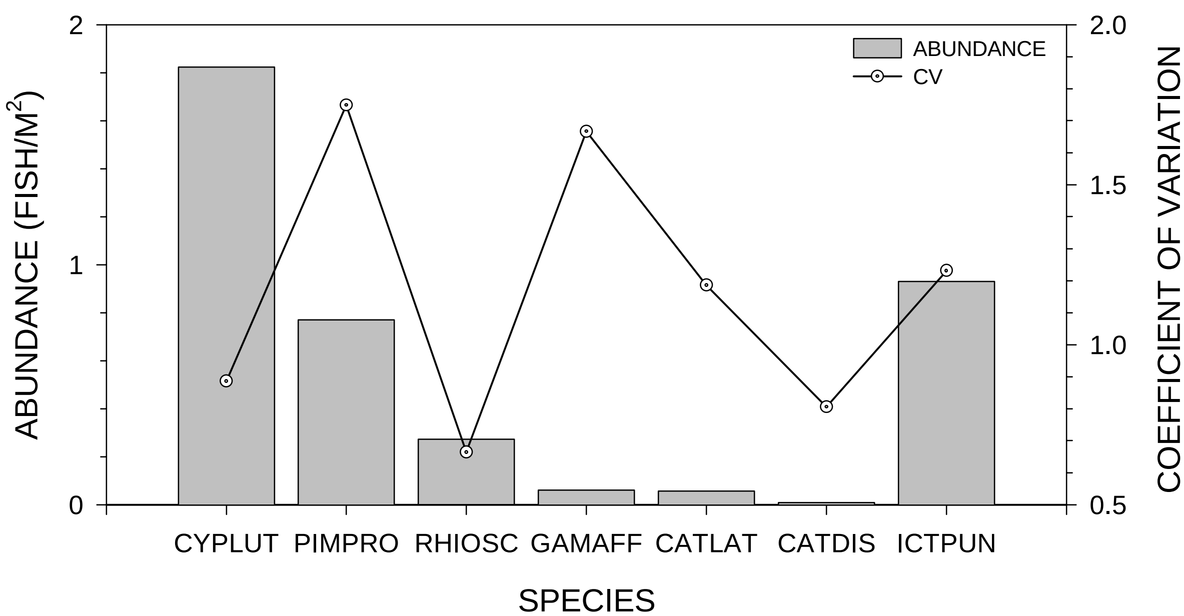

Figure 15. Mean abundance (fish/m^2) and coefficient of variation of abundance of fish species commonly collected during autumn in Geomorphic Reach 3, San Juan River, 1993 - 1999.

Rare Fish Captures

Colorado pikeminnow and roundtail chub were found in secondary channels in both 1998 and 1999. One Colorado pikeminnow was found in Reach 5 in both 1998 and 1999. Two specimens of roundtail chub were found in Reach 4 in 1998 and one was collected there in 1999. Table 17 summarizes data obtained in all Colorado pikeminnow collections in secondary channel habitats from 1997 through 1999.

Table 17. San Juan River secondary channel captures of Colorado pikeminnow, *Ptychocheilus*, during autumn inventories, 1993 – 1999. Parenthetic vakues with TL indicate number of specimens captured in a mesohabitat, if more than one.

DATE	RM	TL (mm)	HABITAT
30 SEP 97	155.5-155.2	50	--
30 SEP 97	155.5-155.2	53	--
30 SEP 97	155.5-155.2	Ca. 50	--
30 SEP 97	155.5-155.2	Ca. 50	--
30 SEP 97	150.3-149.9	Ca. 50 (4)	EDDY POOL
30 SEP 97	150.3-149.9	Ca. 50 (10)	BACKWATER
30 SEP 97	148.5-148.3	Ca. 50 (4)	SHORE RUN
30 SEP 97	148.5-148.3	Ca. 50 (7)	SHORE RUN
30 SEP 97	148.5-148.3	Ca. 50	SHORE RUN
30 SEP 97	148.5-148.3	Ca. 50 (3)	MID-CHANNEL RUN
1 OCT 97	144.0-143.8	Ca. 50	POOL-RUN
1 OCT 97	143.1-142.9	Ca. 50	DEBRIS POOL-RUN
1 OCT 97	143.1-142.9	Ca. 50	SHOAL-RUN
1 OCT 97	143.1-142.9	Ca. 50	RIFFLE
1 OCT 97	141.4-141.05	Ca. 50	SLACKWATER
1 OCT 97	140.6-140.0	Ca. 50	EMBAYMENT
1 OCT 97	138.1-137.9	Ca. 50 (14)	POOL
1 OCT 97	136.6-134.6	Ca. 50 (3)	RIFFLE
2 OCT 97	132.2-131.3	Ca. 50 (130)	BACKWATER POOL
2 OCT 97	130.9-130.75	Ca. 50	MID-CHANNEL RUN
2 OCT 97	129.05-128.9	Ca. 50	RUN
2 OCT 97	128.7-128.1	Ca. 50 (3)	SHOAL-RUN
2 OCT 97	127.7-127.6	Ca. 50	RUN-CHUTE
2 OCT 97	127.2-126.6	Ca. 50	RIFFLE EDDY
2 OCT 97	127.2-126.6	Ca. 50	EDDY
3 OCT 97	117.5-117.2	Ca. 50	POOL
5 OCT 97	103.4-103.2	Ca. 50 (2)	DEBRIS POOL
5 OCT 97	103.4-103.2	Ca. 50 (2)	SHOAL
5 OCT 97	103.4-103.2	Ca. 50 (2)	DEBRIS POOL
5 OCT 97	99.05-98.6	Ca. 50	POOL
6 OCT	87.7-87.5	Ca. 50	POOL
6 OCT	87.7-87.5	Ca. 50	DEBRIS POOL
30 SEP 98	132.2-132.2	167	MID-CHANNEL RUN
20 SEP 99	136.5-134.4	124	SHORE RUN

Among Geomorphic Reach Comparisons (1998-1999)

In 1998, assemblage diversity was almost the same in Reaches 5 through 3, but declined from Reach 5 through 3 in 1999 (Figure 16). Total abundance of fishes was greatest in Reach 3 in both years (Figure 17). In Reaches 5 and 4, however, it was substantially less in 1999 than 1998.

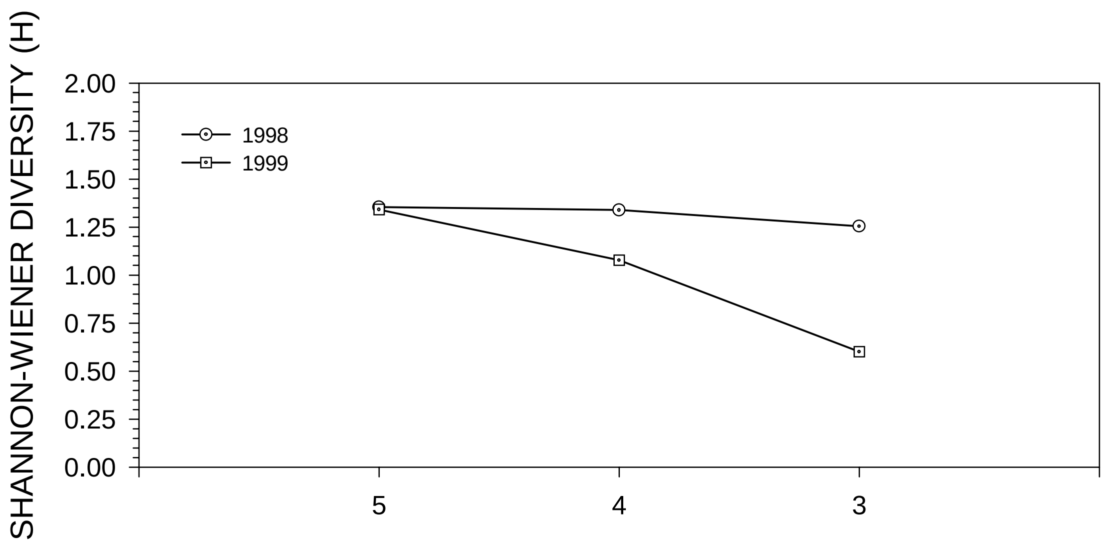

Figure 16. Shannon-Wiener Diversity (H) of fish assemblages in San Juan River secondary channels during autumn, 1998 - 1999.

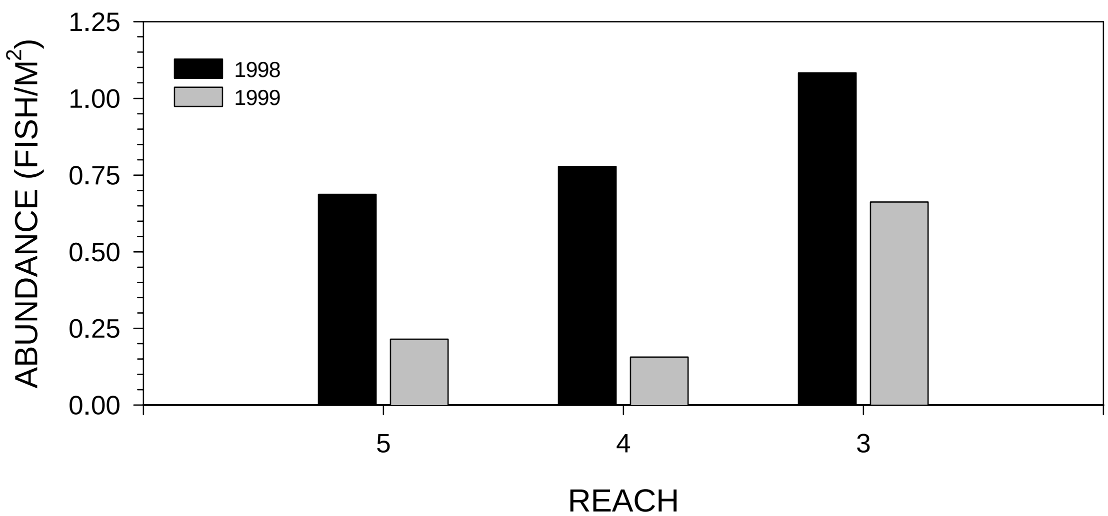

Figure 17. Abundance (fish/m^2) of fishes in San Juan River secondary channels during autumn, 1998 - 1999.

RESPONSE TO SPRING AND SUMMER FLOW ATTRIBUTES

Spring Runoff Attributes

Five attributes of spring runoff were compared to autumn abundance of seven fish species commonly collected in autumn from Geomorphic Reaches 5 through 3. Linear regression analysis was used to characterize relationships of abundance with flow attributes. Data (fish and discharge) from 1993 through 1999 were used in comparisons.

Autumn abundance of red shiner was not significantly related to any attribute of spring runoff. In Reaches 5 and 4, strongest correlations were between days discharge > 5000 cfs and abundance (Figure 18a and 18b), but in Reach 3 the strongest was with days discharge > 8000 cfs (Figure 18c).

Autumn abundance of fathead minnow was not related to any attribute of spring runoff in Reach 5; slopes of all were negative and that with days discharge > 8000 cfs was typical (Figure 18d). In Reach 4, relationships were negative and stronger than in Reach 5, but not significant. The strongest in Reach 4 was between abundance and spring discharge volume (Figure 18e). In contrast to Reaches 5 and 4, abundance of fathead minnow in Reach 3 was positively, but not significantly, related to spring runoff attributes; the relationship was strongest with days discharge > 8000 cfs.

In Reaches 5 and 4, autumn abundance of speckled dace was positively and significantly related to all attributes of spring runoff except days discharge > 8000 cfs. The strongest relationship was with days discharge > 5000 cfs in both reaches (Figure 19a and 19b). In Reach 3, no attribute of spring runoff was significantly related to

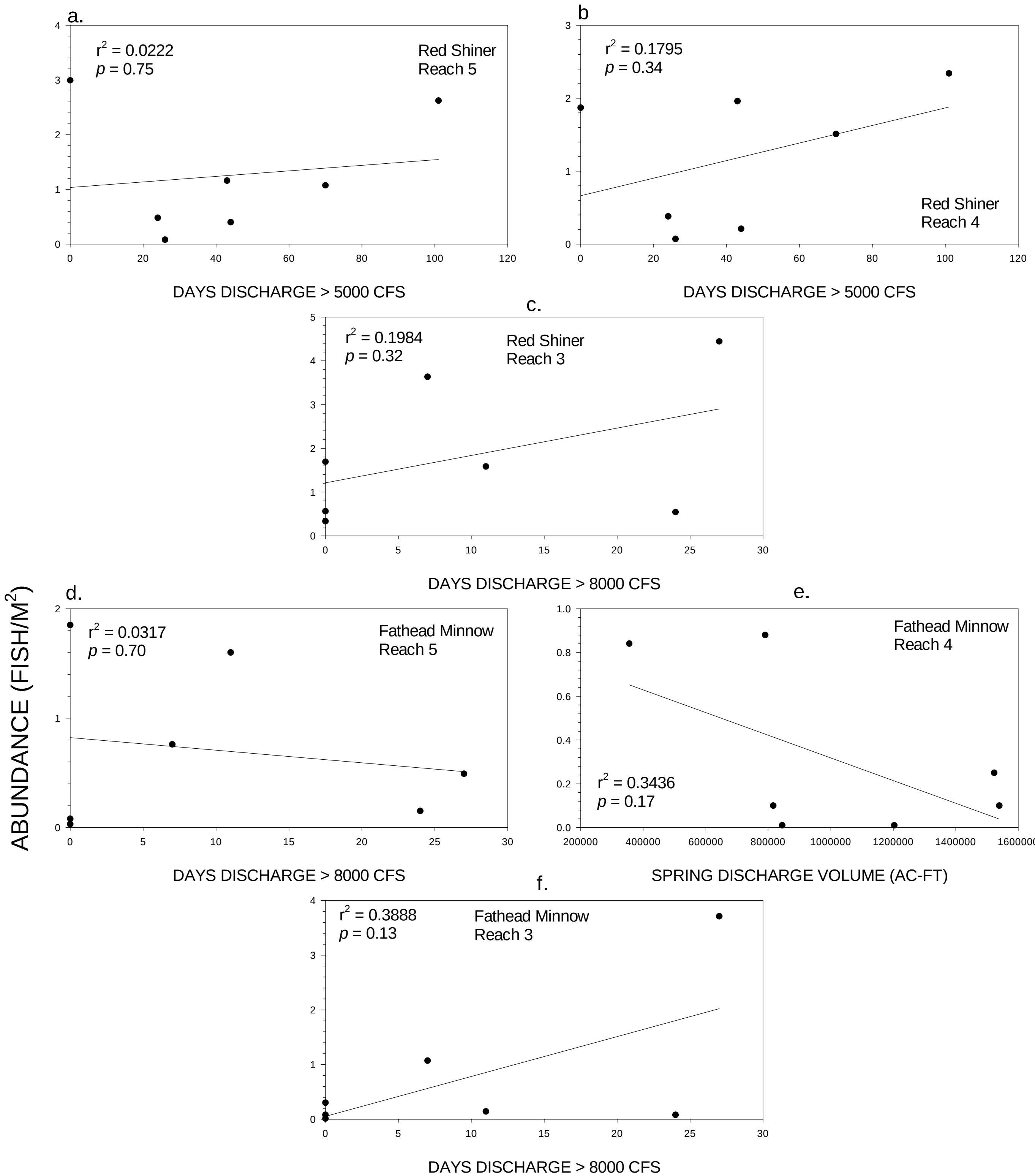

Figure 18 . Relationship of red shiner (a, b, & c) and fathead minnow (c,d, & e) autumn abundance with attributes of spring runoff, San Juan River, 1993 - 1999.

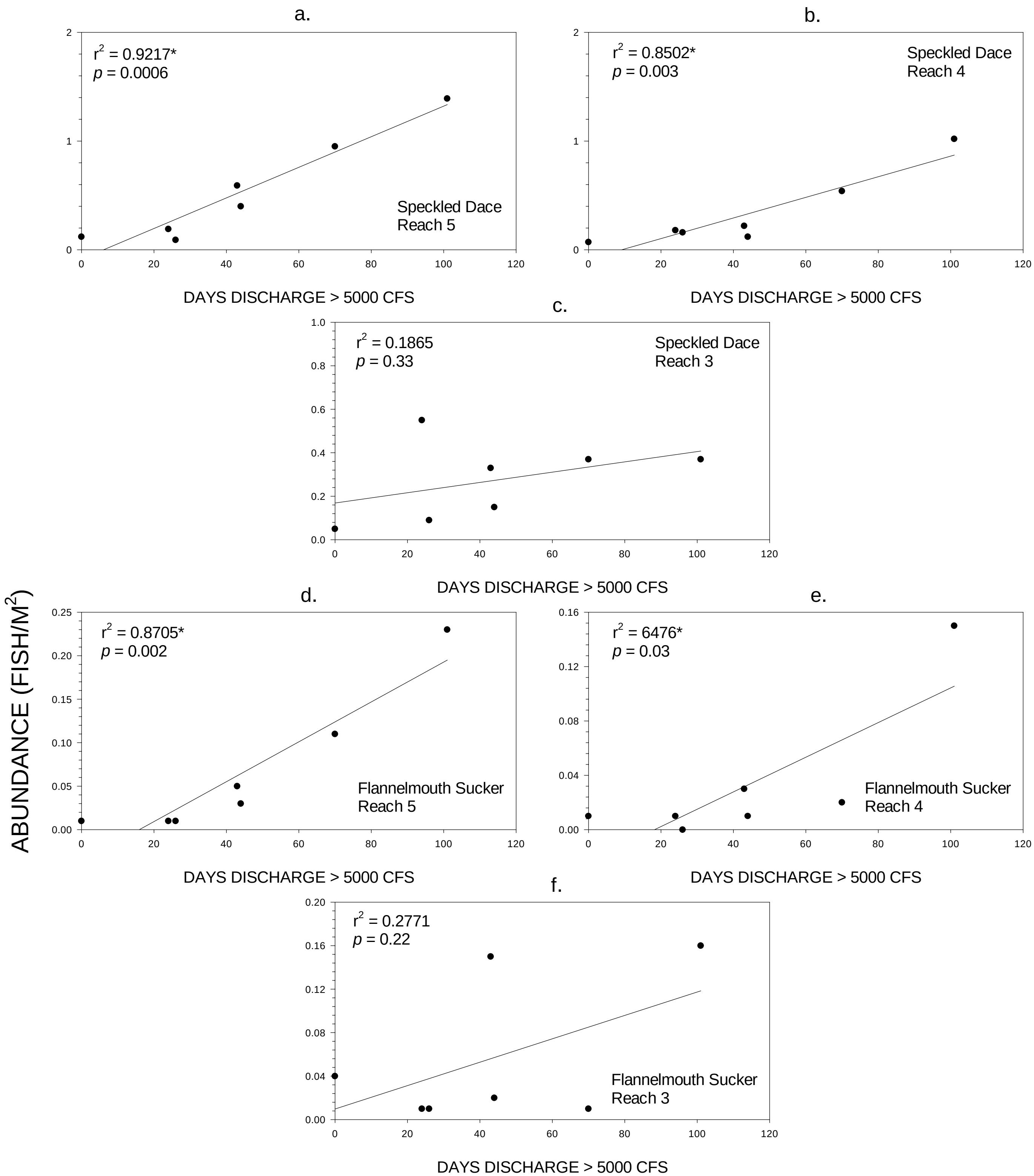

Figure 19. Relationship of speckled dace (a, b, and c) and flannelmouth sucker (d,e, and f) autumn abundance with attributes of spring runoff, San Juan River, 1993 - 1999.

autumn abundance, but all were positive. The strongest was with days discharge > 5000 cfs (Figure 19c).

Autumn abundance of flannelmouth sucker was significantly related to all attributes of spring runoff, except days discharge > 8000 cfs in Reaches 5 and 4 (Figure 19d and 19e). No relationship was significant in Reach 3; the strongest was with days discharge > 5000 cfs. All relationships in all reaches were positive.

In Reach 5, autumn abundance of bluehead sucker was significantly related to three attributes of spring runoff (mean, days discharge > 3000 cfs, and days discharge > 5000 cfs); the strongest was with days discharge > 5000 cfs (Figure 20a). In Reach 4, its autumn abundance was significantly related only to days discharge > 5000 cfs (Figure 20b). No correlations were significant in Reach 3, but the strongest was with days discharge > 8000 cfs (Figure 20c). All relationships were positive.

Autumn abundance of channel catfish was not or negatively related to spring runoff attributes in Reaches 5 and 4. In Reach 5, the strongest relationship was with runoff volume (Figure 20d) and in Reach 4 with days discharge > 8000 cfs (Figure 20e). Opposites relationships were found in Reach 3; autumn abundance was positively related to most spring runoff attributes. The relationship between days discharge > 5000 cfs and abundance was significant (Figure 20f).

Spring runoff attributes were negatively or not related to autumn abundance of western mosquitofish. In Reaches 5 and 4, spring runoff volume was negatively, but not significantly, related to autumn abundance (Figure 21a and 21b). In Reach 3, there was no relationship between abundance and all spring runoff attributes (Figure 21c).

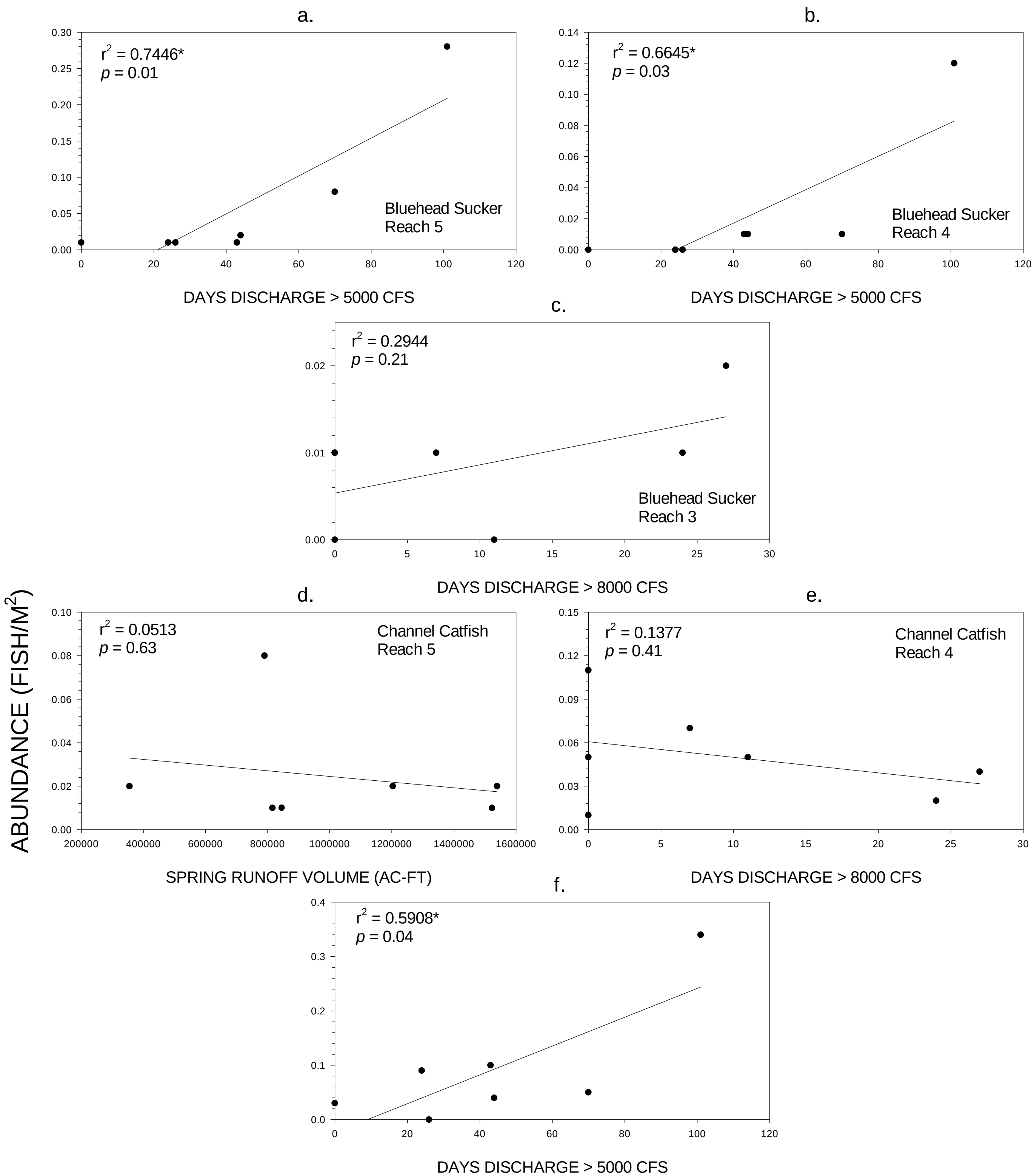

Figure 20. Relationship of bluehead sucker (a, b, and c) and channel catfish (d, e, and f) autumn abundance with attributes of spring runoff, San Juan River, 1993 -1999.

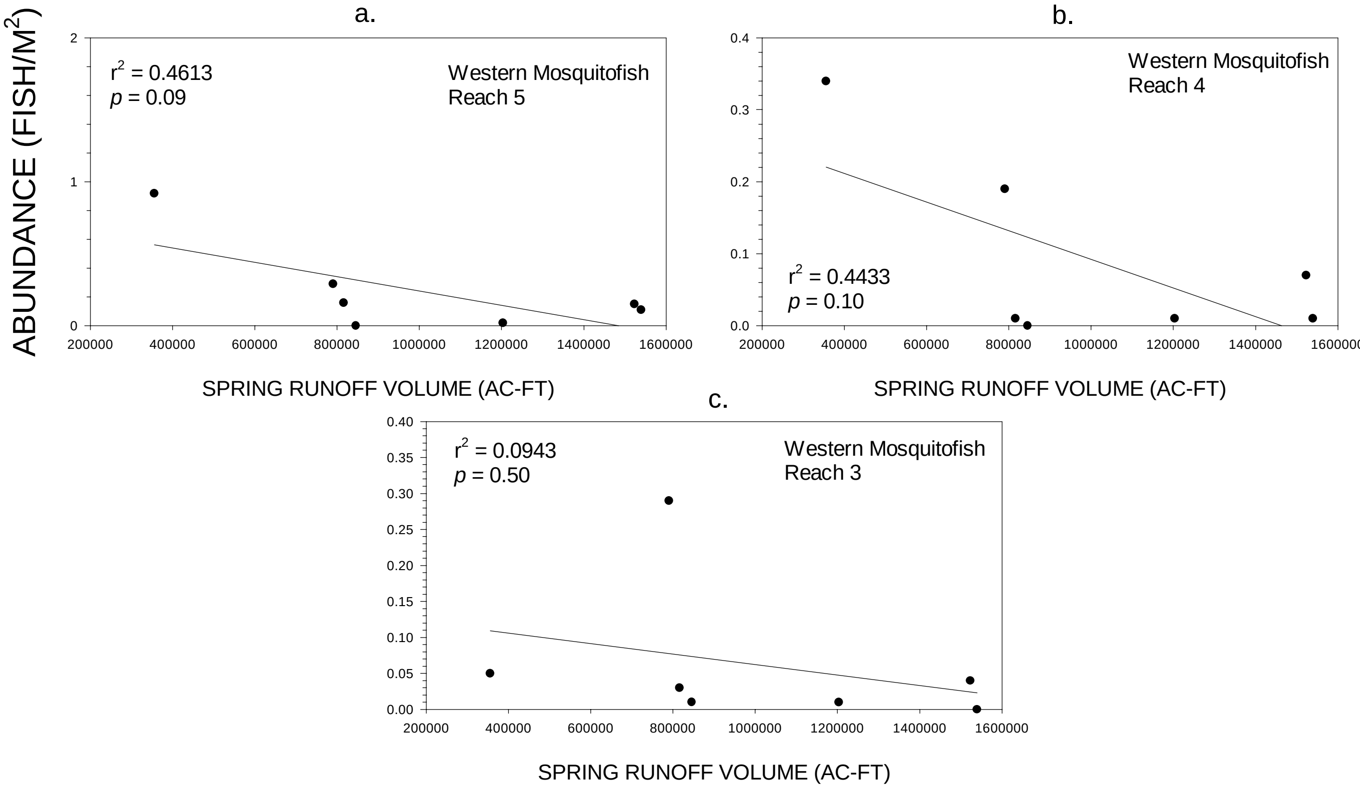

Figure 21. Relationship of western mosquitofish autumn abundance (fish/m^2) with attributes of spring runoff, San Juan River, 1993 - 1999.

Summer Discharge Attributes

Autumn abundance of red shiner in Reach 5 was negatively, but not significantly, related to elevated summer discharge (Figure 22). Of these relationships the strongest was with days discharge > 1000 cfs. Its abundance was positively, but not significantly, related to diminished summer discharge; the strongest was with days discharge < 500 cfs. In Reach 4, red shiner abundance was also negative related to all attributes of elevated summer discharge and significantly so with flow spike duration (Figure 23). As in Reach 5, red shiner abundance was positively related to diminished summer discharge. Most relationships in Reach 4 were stronger than in Reach 5. Most relationships in Reach 3

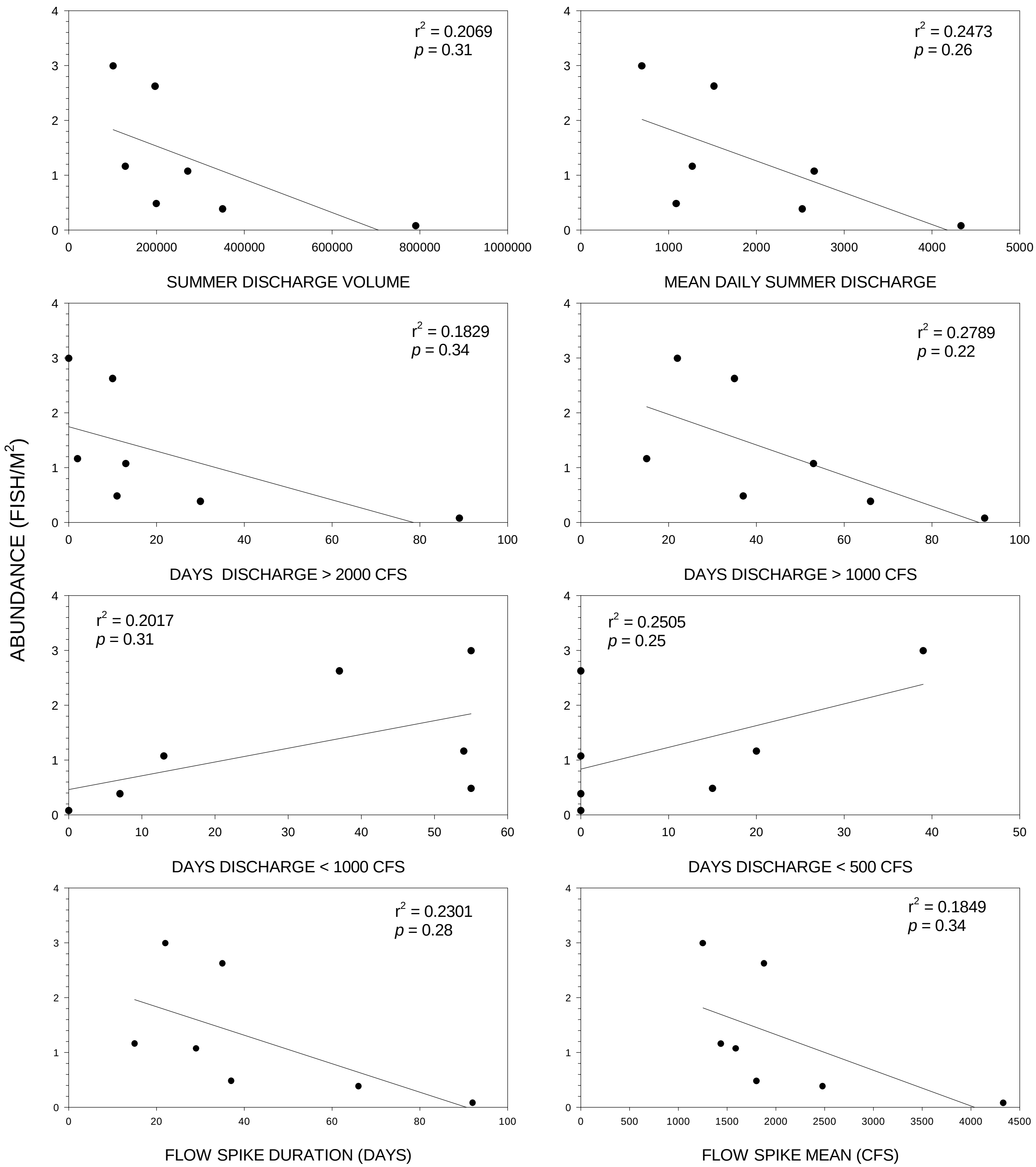

Figure 22. Relationship of red shiner autumn density (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, San Juan River, 1993 - 1999.

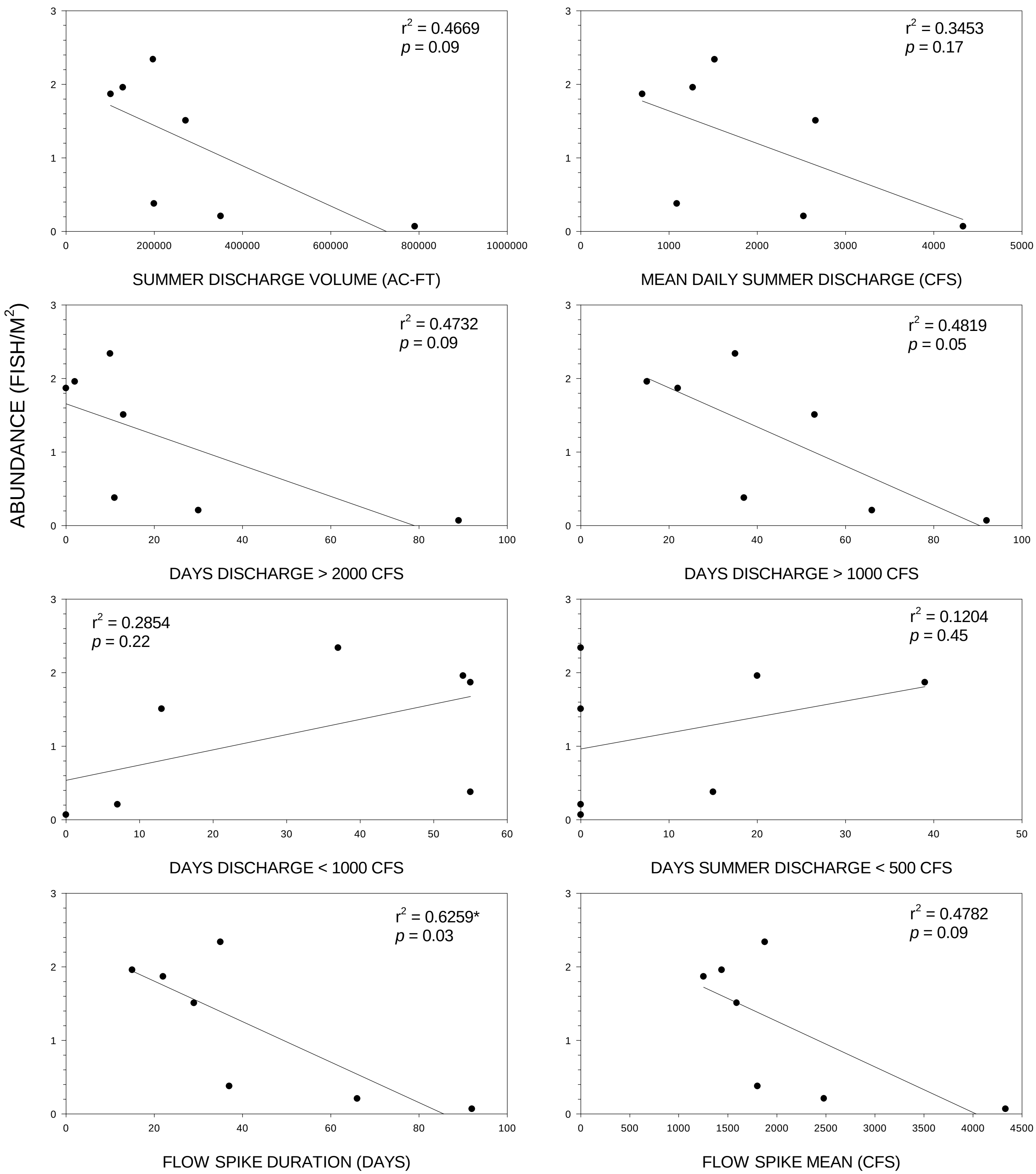

Figure 23. Relationship of red shiner autumn density (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

were weaker than in Reach 4 (Figure 24); only days discharge > 1000 cfs and flow spike duration had fairly strong relationships (but not significant). There was no relationship between diminished summer discharge and abundance in Reach 3.

Autumn abundance of fathead minnow was negatively, but not significantly, related to elevated summer discharge in Reach 5 (Figure 25); the strongest was with days discharge > 1000 cfs. Its abundance was positively related with diminished summer discharge. Days discharge > 1000 cfs was negatively, and significantly, related to autumn abundance of fathead minnow in Reach 4 (Figure 26). Days discharge < 500 cfs was positively, and significantly, related to abundance. No other summer discharge attribute was significantly related to autumn abundance, but most were fairly strong. No summer discharge attribute was significantly related to autumn abundance of fathead minnow in Reach 3 (Figure 27), and all (albeit weak) were negative.

There was no relationship between any summer discharge attribute and autumn abundance of speckled dace in Reach 5 (Figure 28). The extended high flows of summer 1999 skewed relationships. For example, if the 1999 mean summer discharge point was not included, the relationship between summer discharge and abundance was positive, but not significant. Relationships (the lack) in Reaches 4 and 3 were similar to those in Reach 5 (Figures29 and 30).

Autumn abundance of flannelmouth sucker was generally not related to any attribute of summer discharge in Reach 5; the strongest, and negative, was with days discharge < 500 cfs (Figure 31). In Reaches 4 and 3, there was no relationship with any summer discharge attribute (Figures 32 and 33).

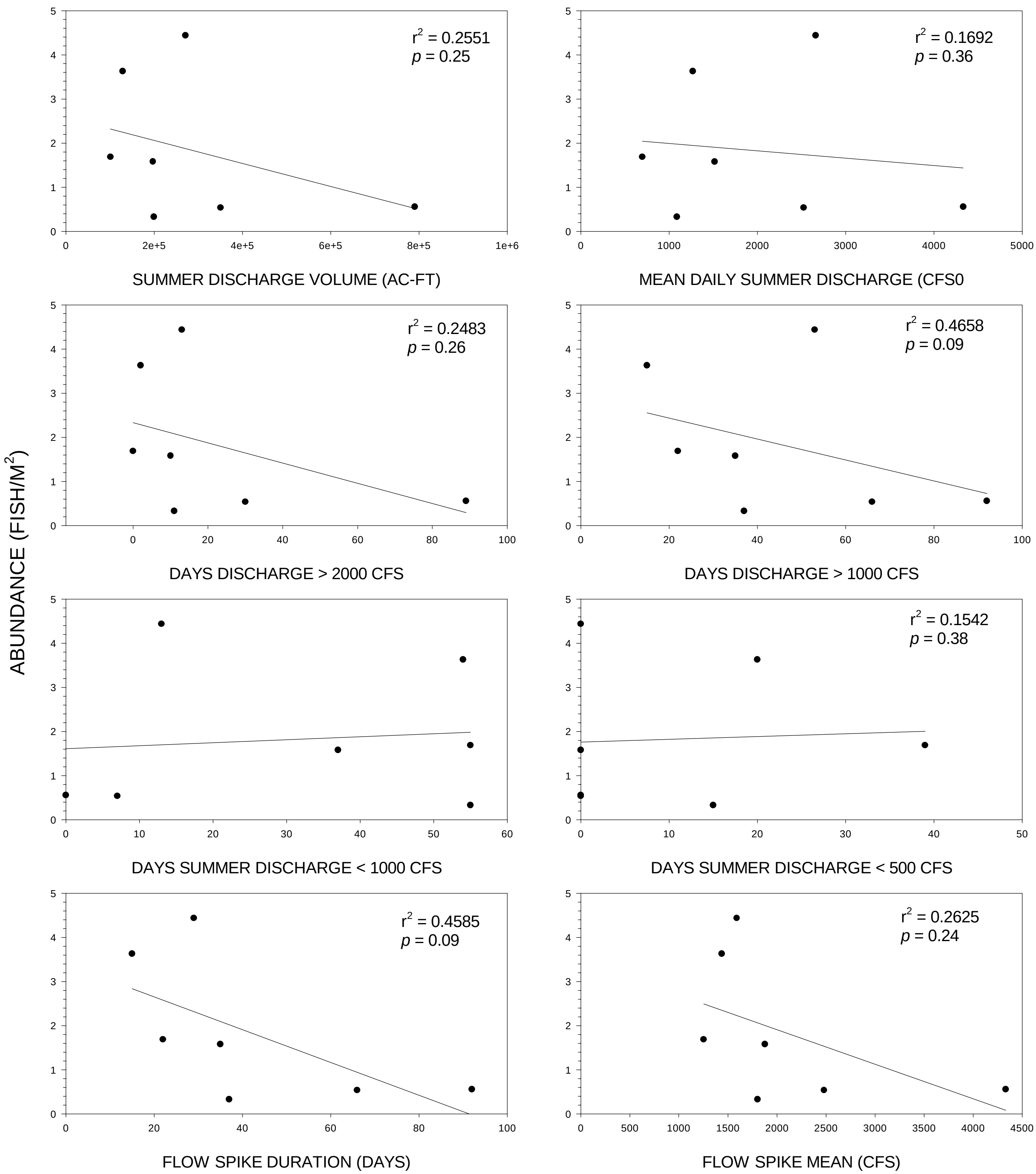

Figure 24. Relationship or red shiner density (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

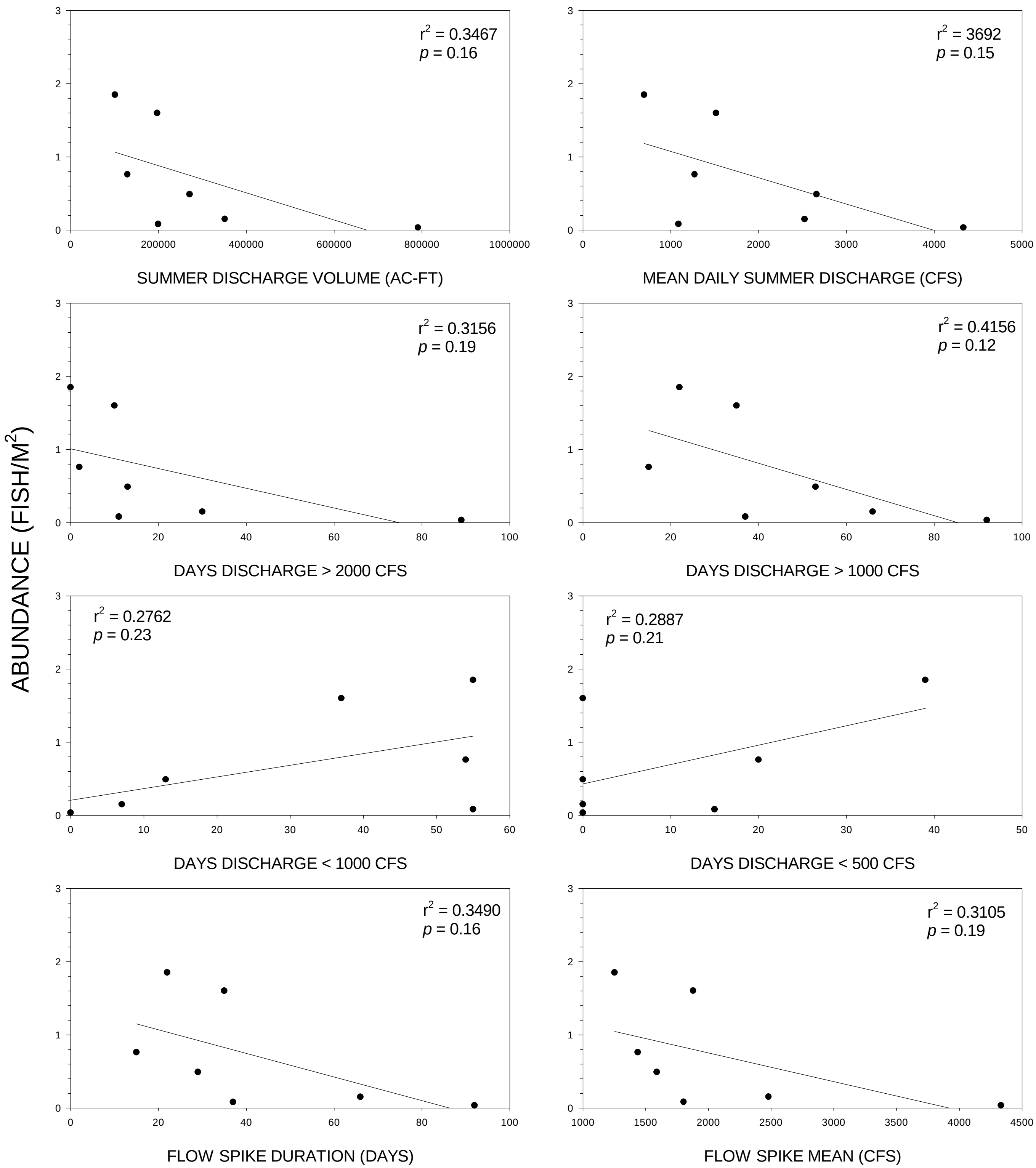

Figure 25. Relationship of fathead minnow autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, San Juan River, 1993 - 1999.

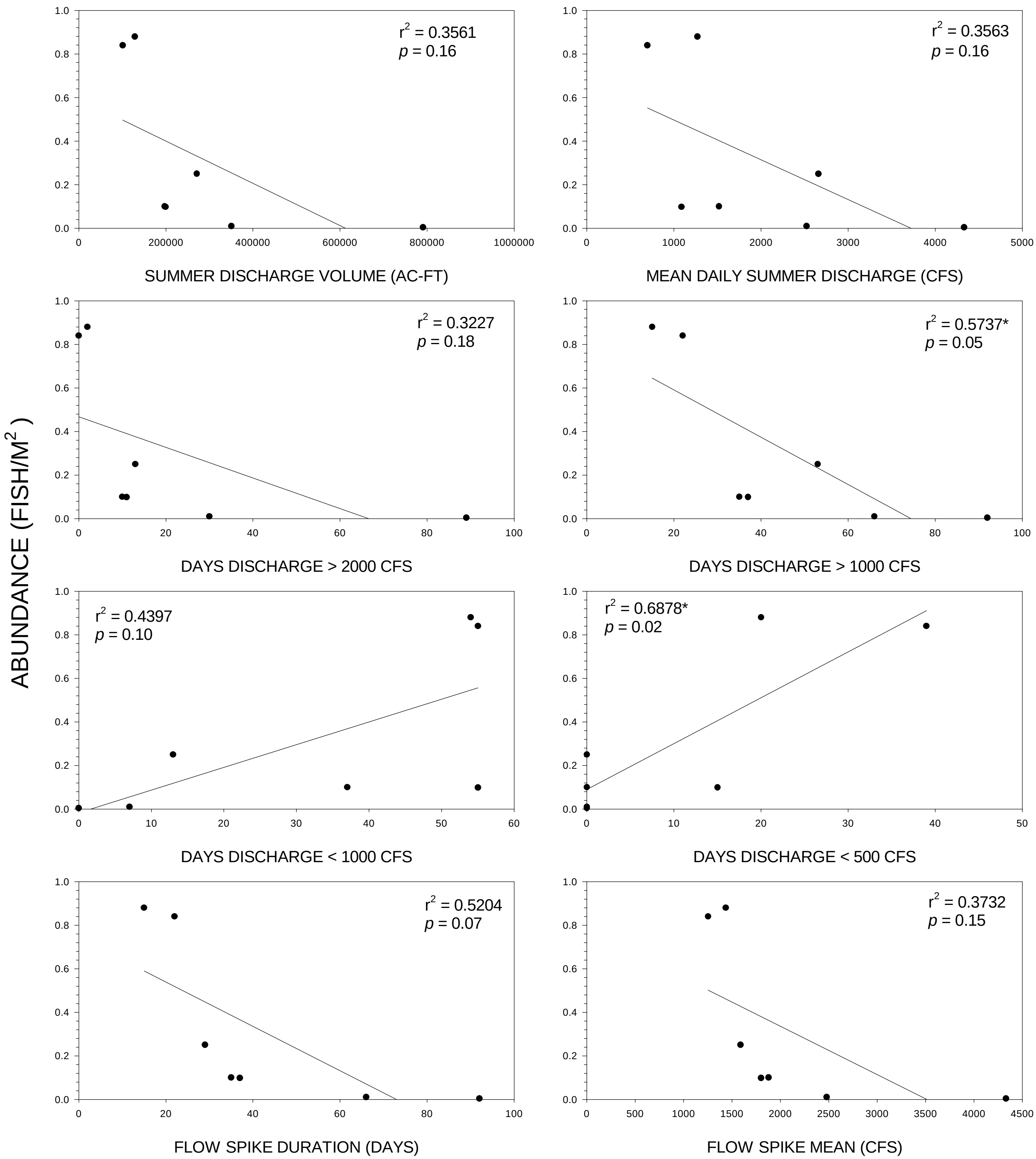

Figure 26. Relationship of fathead minnow abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

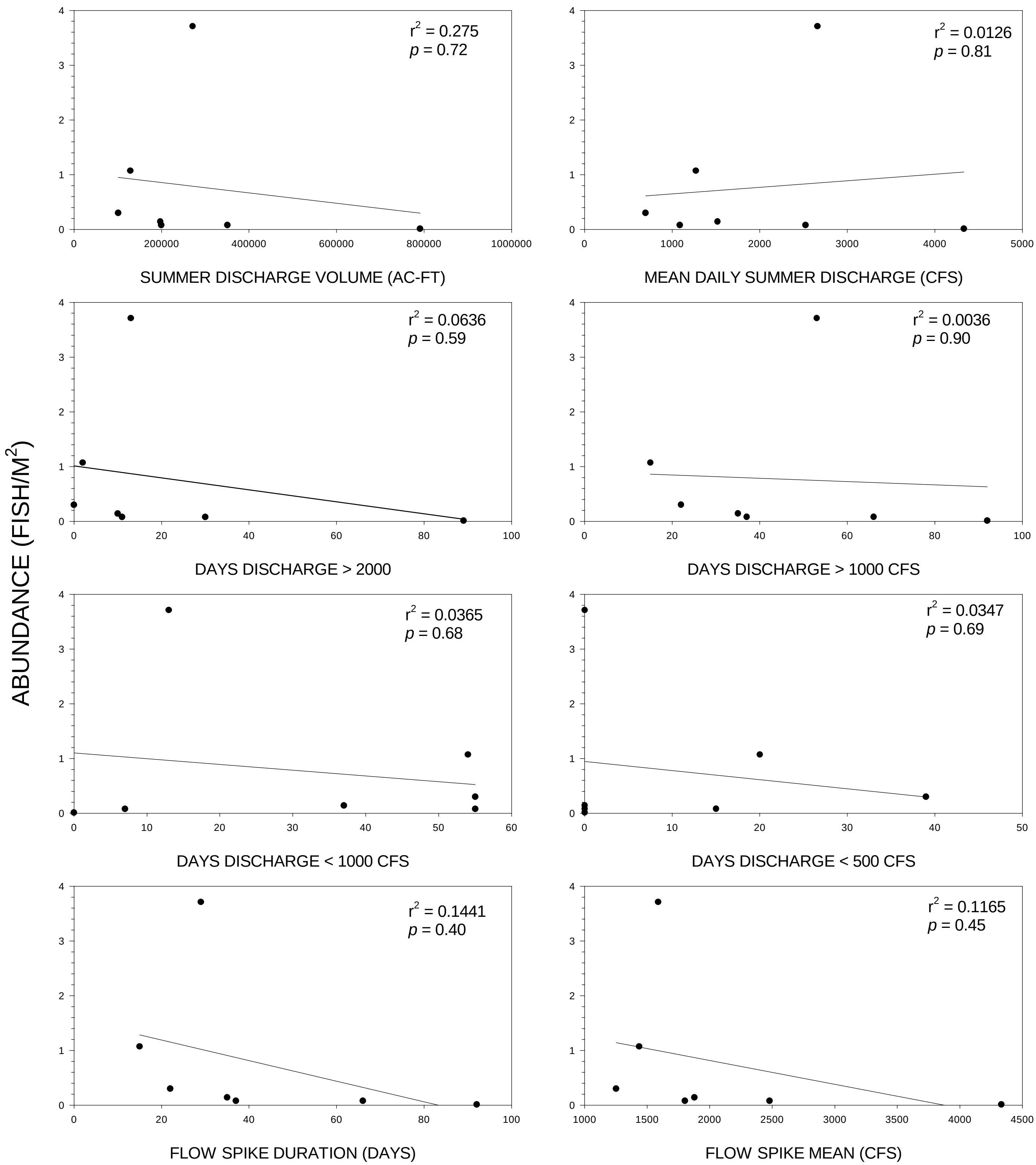

Figure 27. Relationship of fathead minnow autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

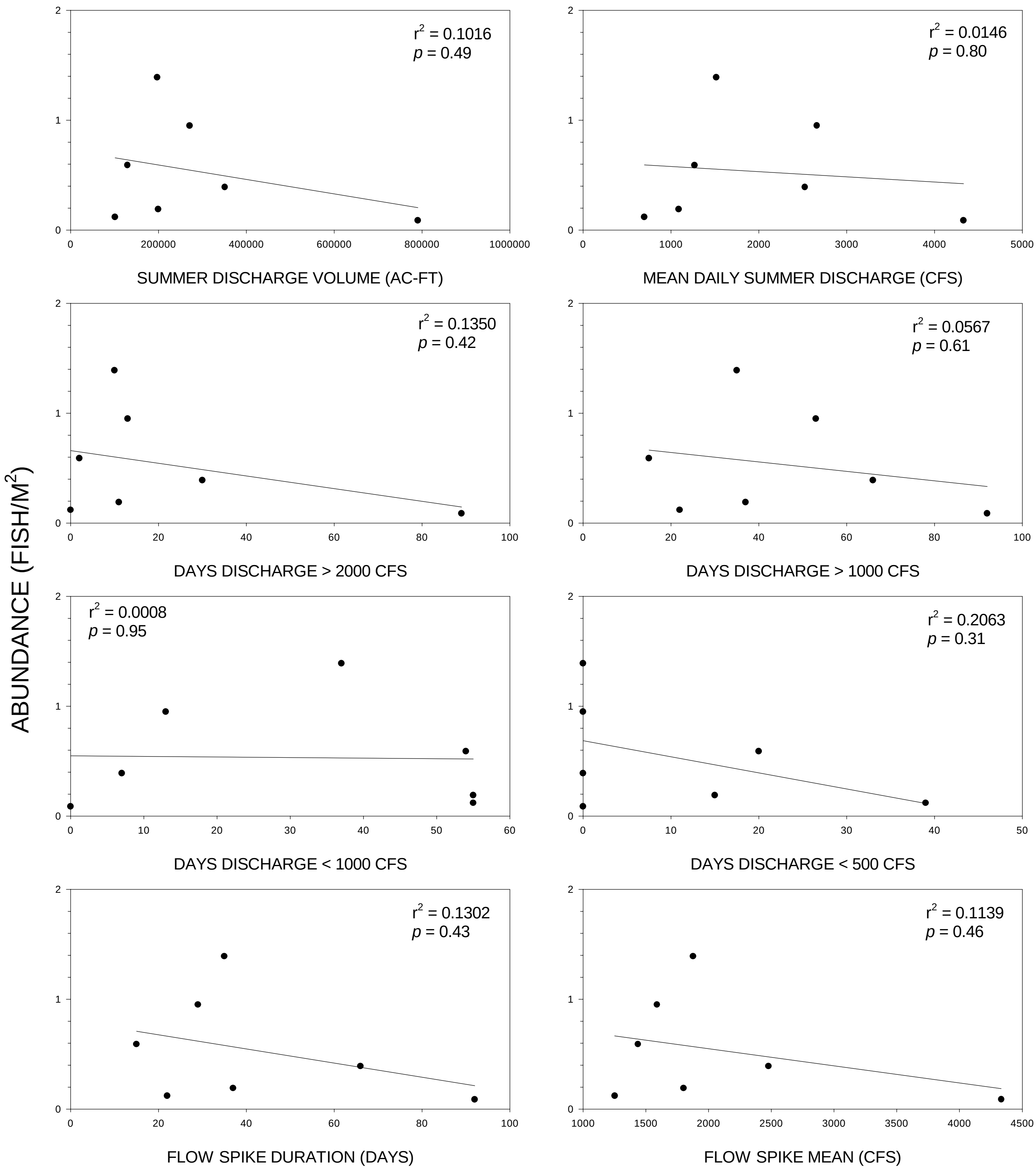

Figure 28. Relationship of speckled dace autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, San Juan River, 1993 - 1999.

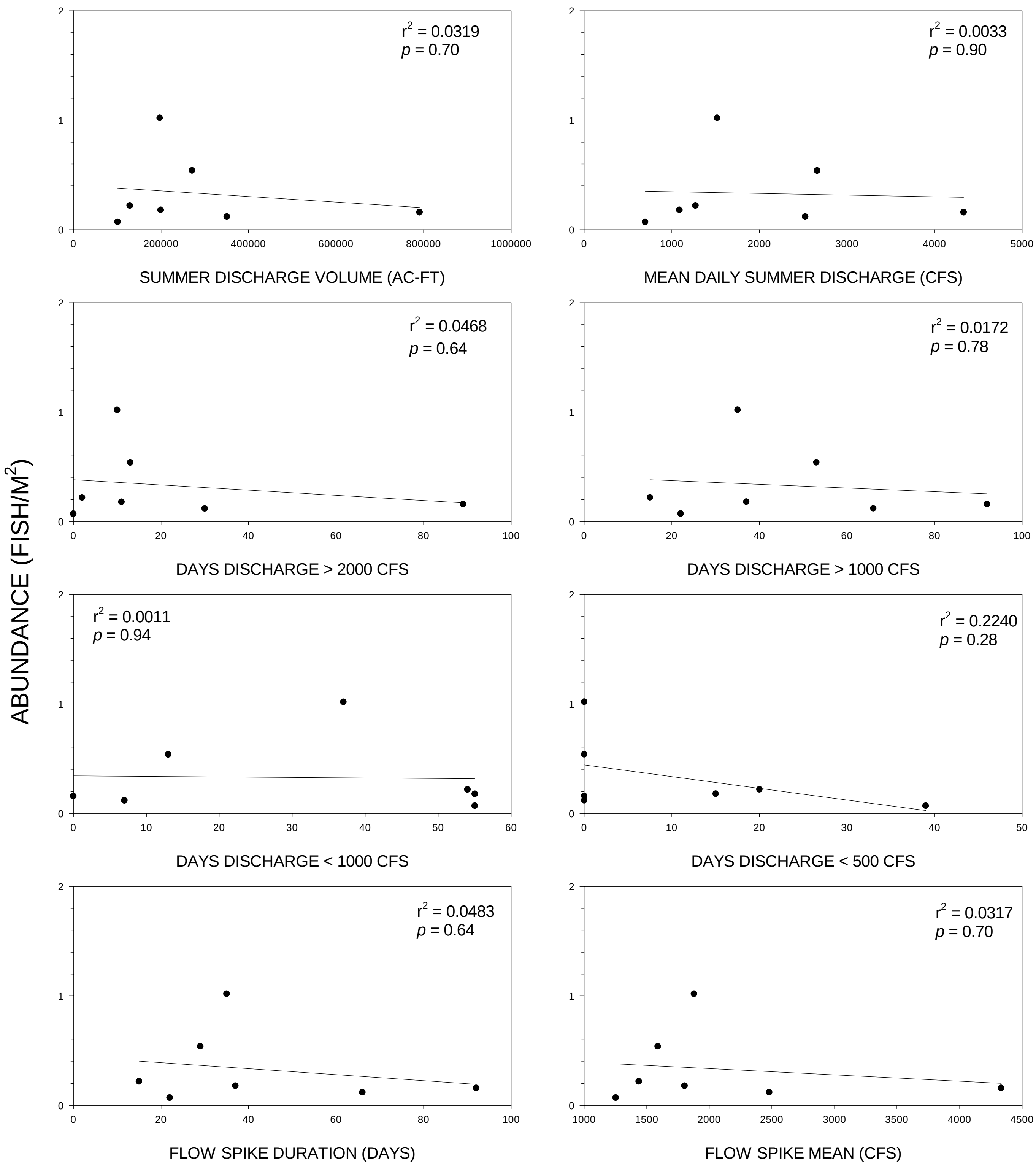

Figure 29. Relationship of speckled dace autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

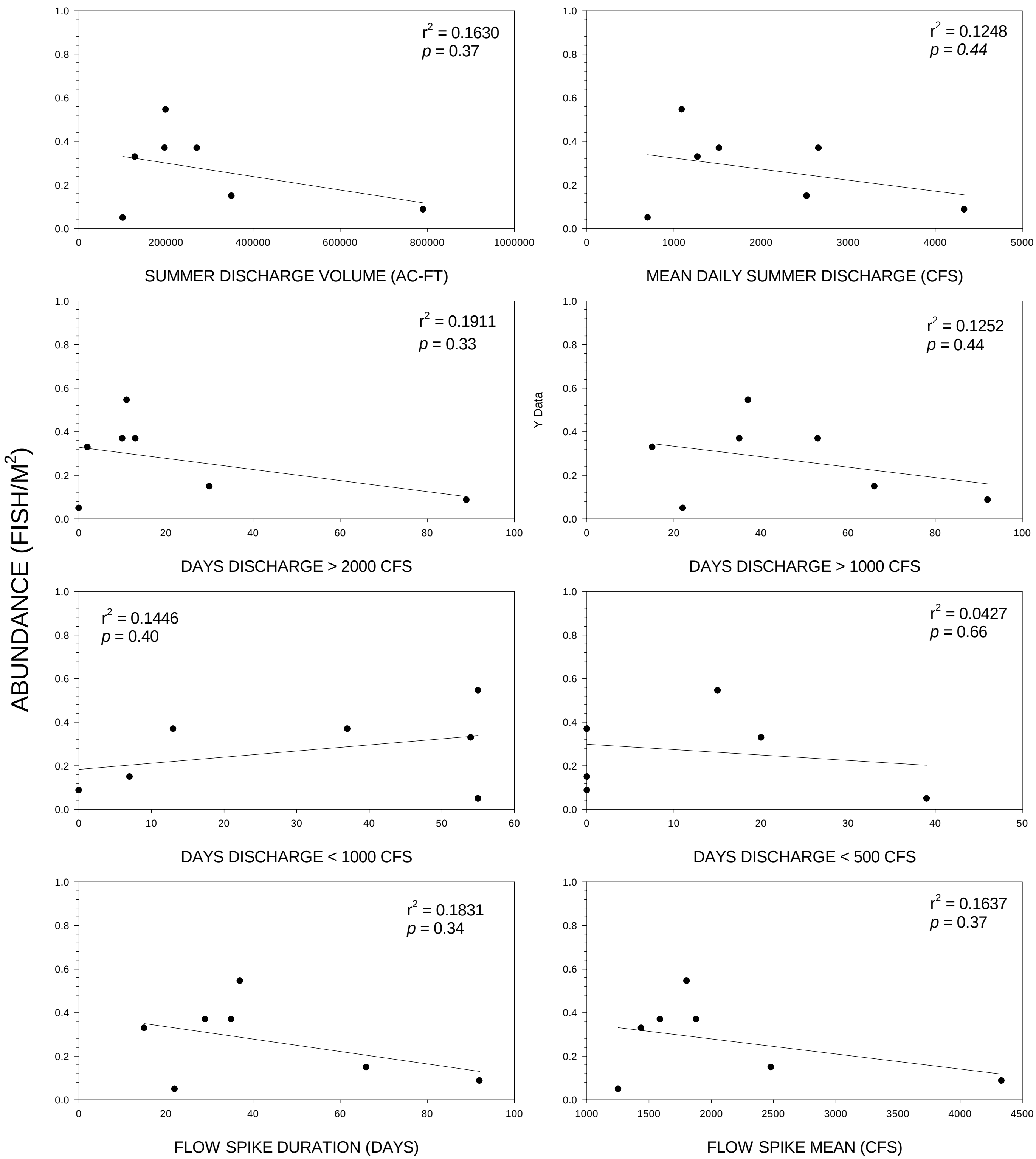

Figure 30. Relationship of speckled dace autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

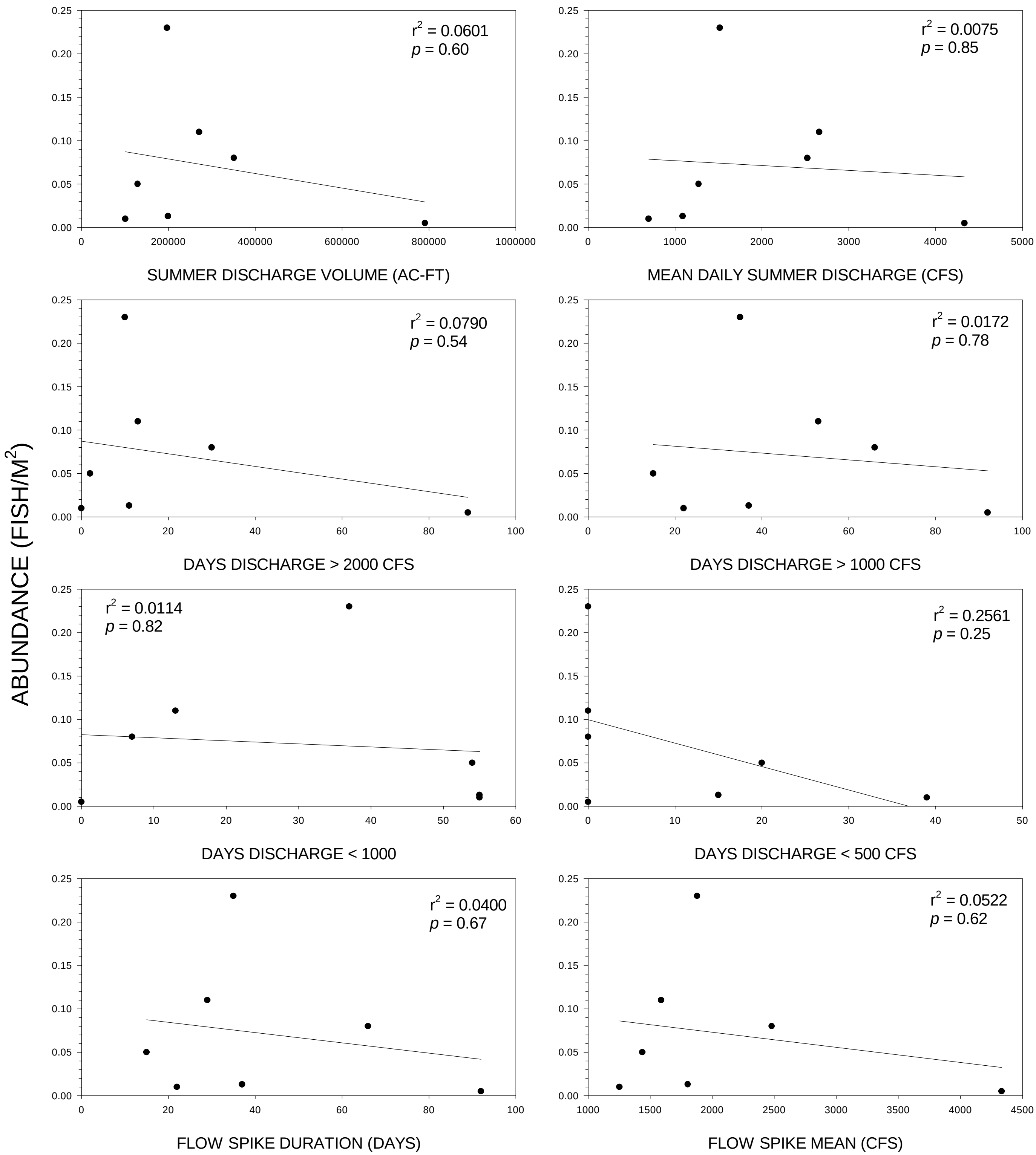

Figure 31. Relationship of flannelmouth sucker autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, San Juan River, 1993 - 1999.

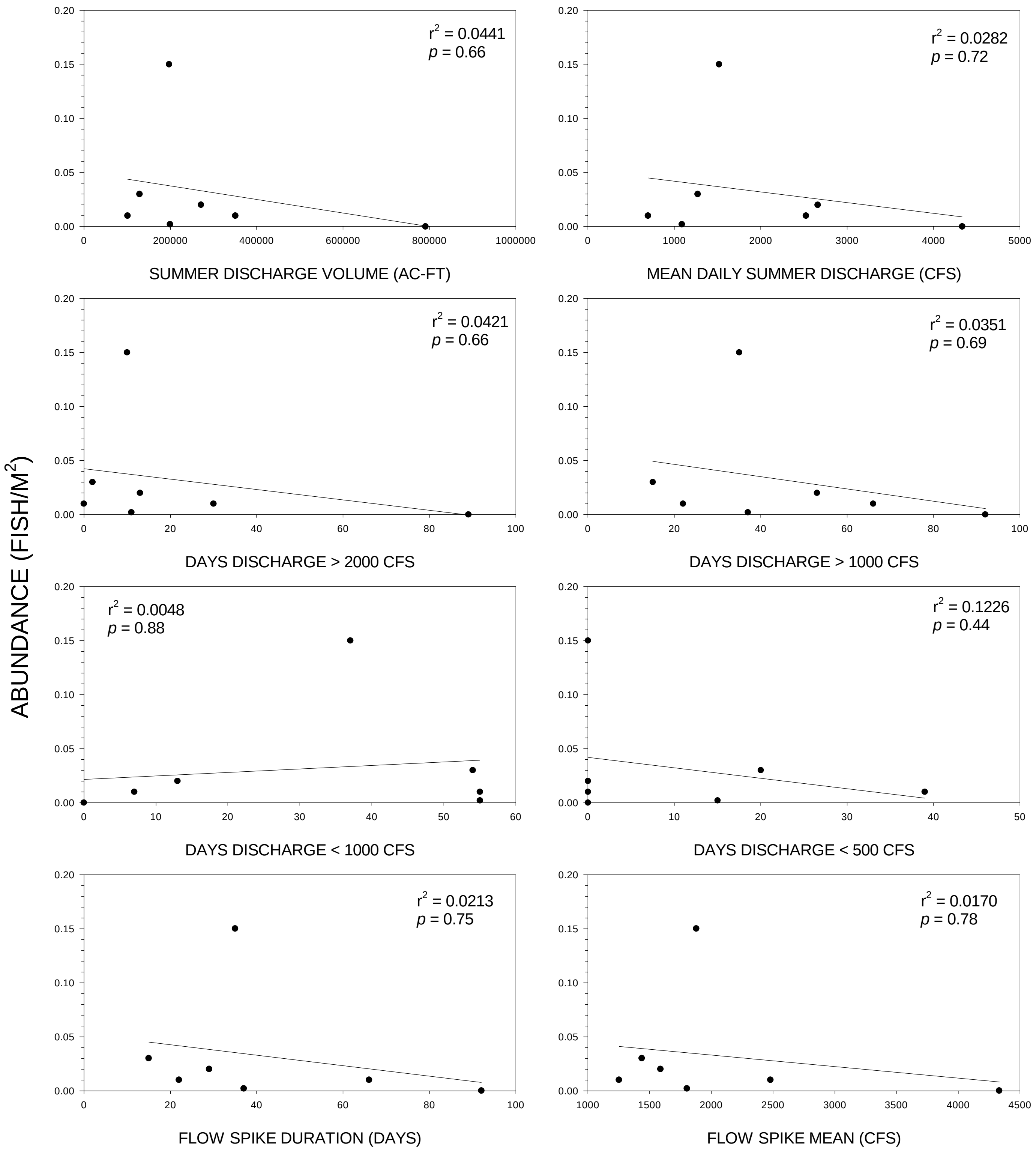

Figure 32. Relationship of flannelmouth sucker autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

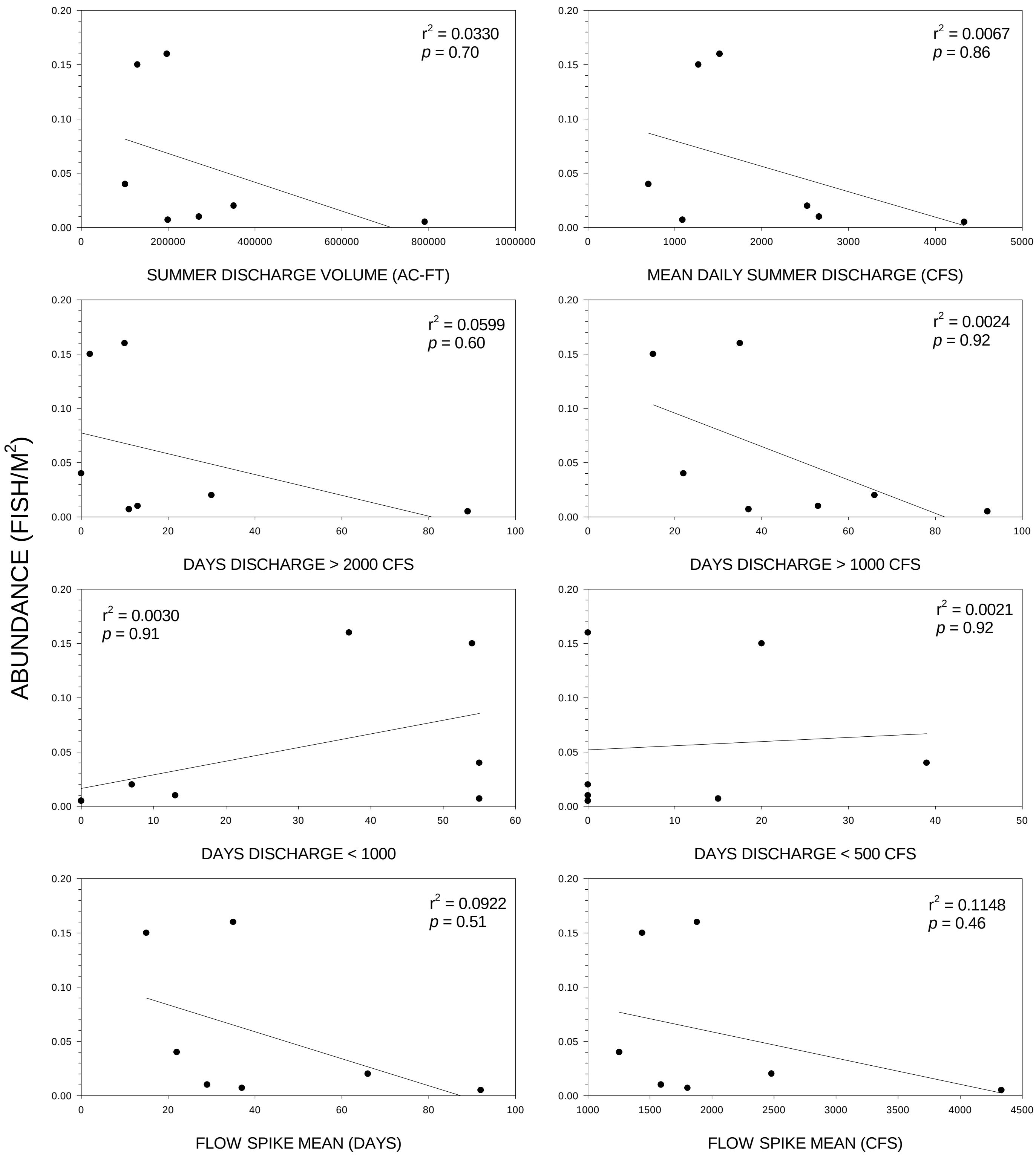

Figure 33. Relationship of flannelmouth sucker autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

No attribute of summer discharge was significantly related to autumn abundance of bluehead sucker. In Reach 5, the strongest was with days discharge < 500 cfs (Figure 34), in Reach 4 there was none (Figure 35), and in Reach 3 there was none (Figure 36).

Autumn abundance of channel catfish was negatively, but not significantly, related to elevated summer discharge, but not related to diminished summer discharge (Figure 37). The strongest relationship was with days discharge > 1000 cfs. In Reach 4, autumn abundance was significantly related to mean summer discharge (negative) and days discharge < 100 cfs (positive). All other relationships, except days discharge < 500 cfs, were fairly strong (Figure 38). There were no relationships between summer discharge and autumn abundance in Reach 3 (Figure 39).

In Reach 5, autumn abundance of western mosquitofish was negatively related to elevated summer discharge and positively to diminished flows (Figure 40). The relationship of abundance with days discharge < 500 cfs was significant and all others were fairly strong. In Reach 4, relationships were weaker, but that between days discharge < 500 cfs and abundance was nonetheless significant (Figure 41). Although the general pattern persisted of negative relationships with elevated flow and positive with diminished discharge, no relationship in Reach 3 was significant (Figure 42).

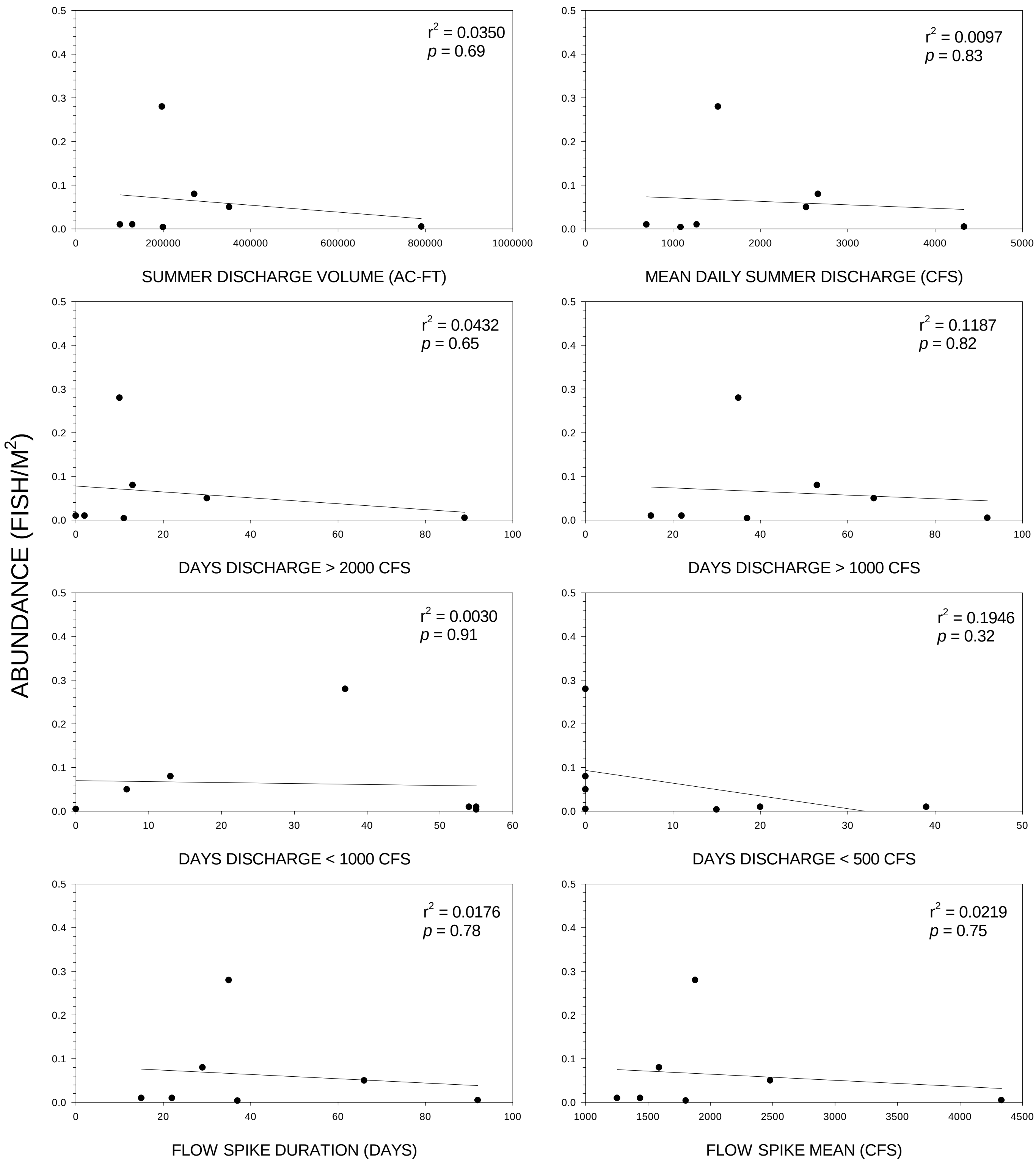

Figure 34. Relationship of bluehead sucker autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, 1993 - 1999.

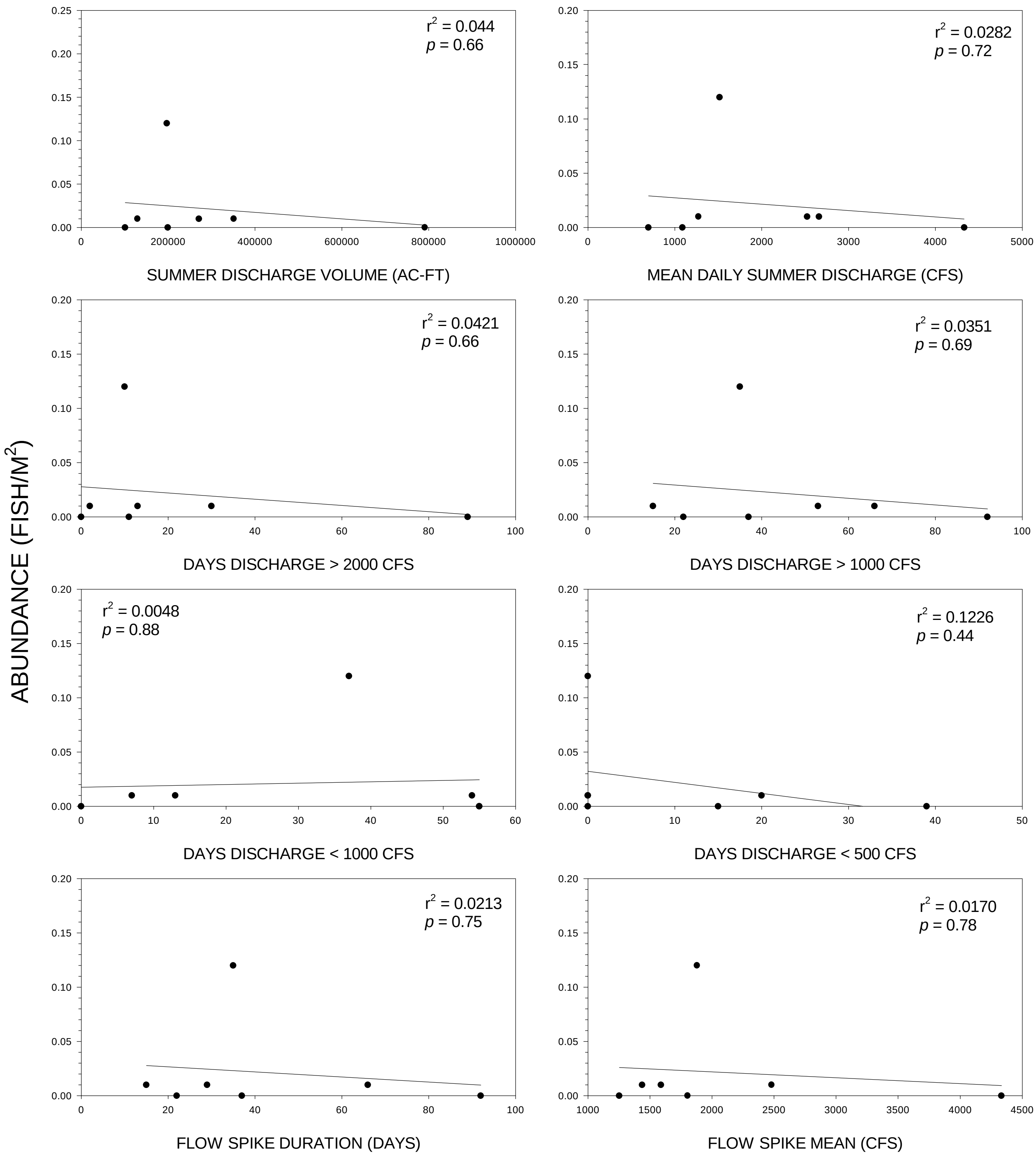

Figure 35. Relationship of bluehead sucker autumn abunance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

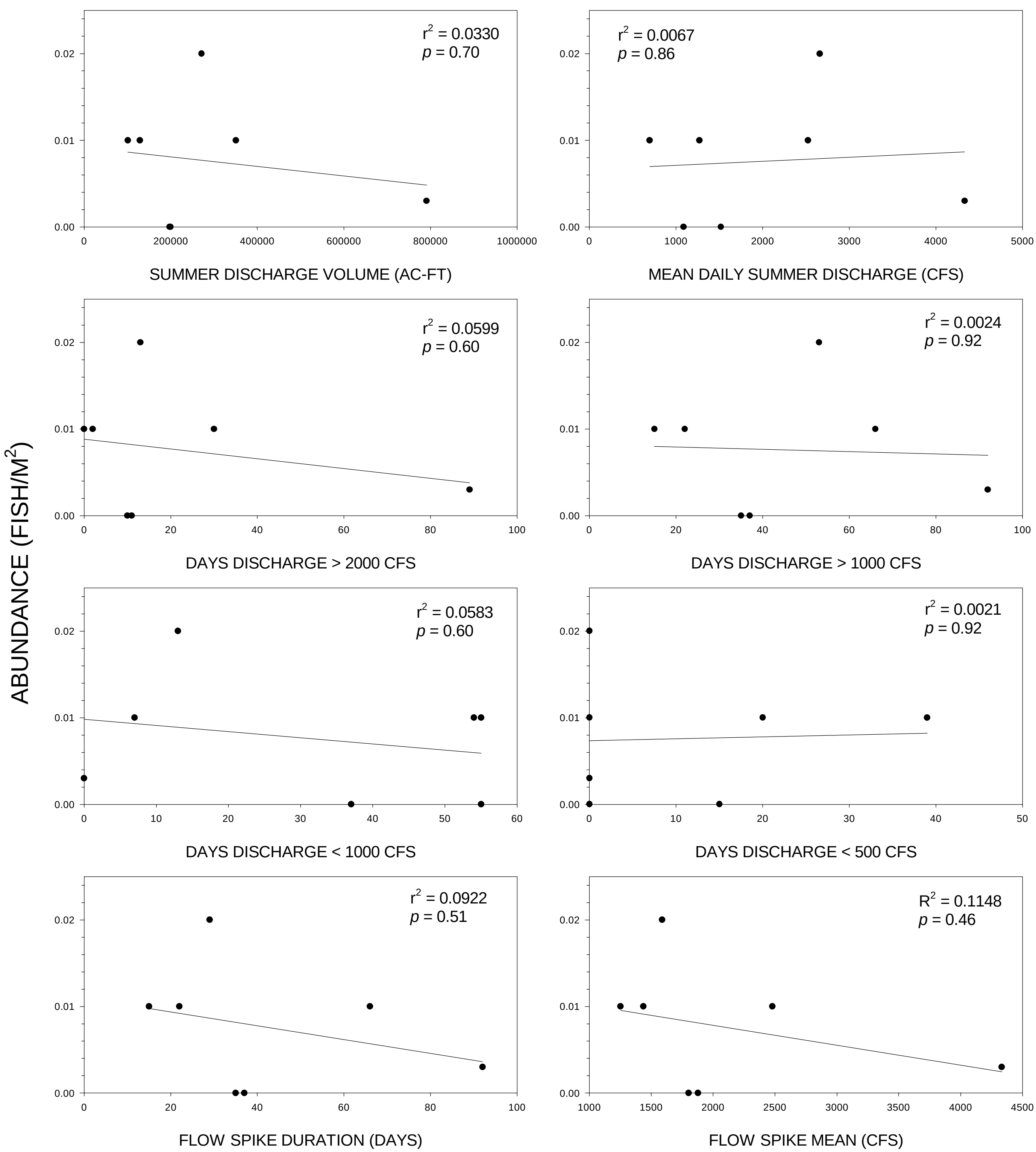

Figure 36. Relationship of bluehead sucker autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

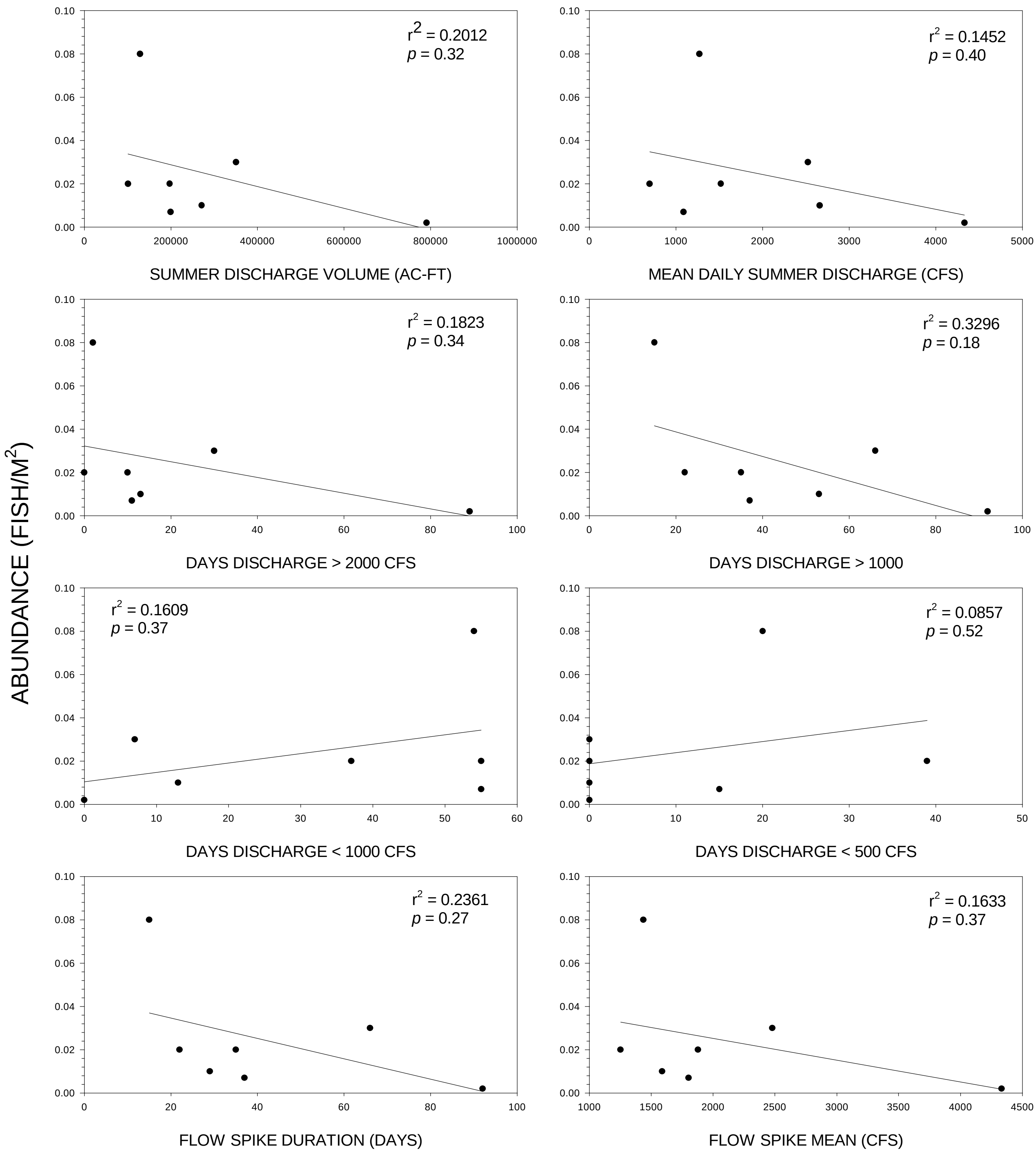

Figure 37. Relationship of channel catfish autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, San Juan River, 1993 - 1999.

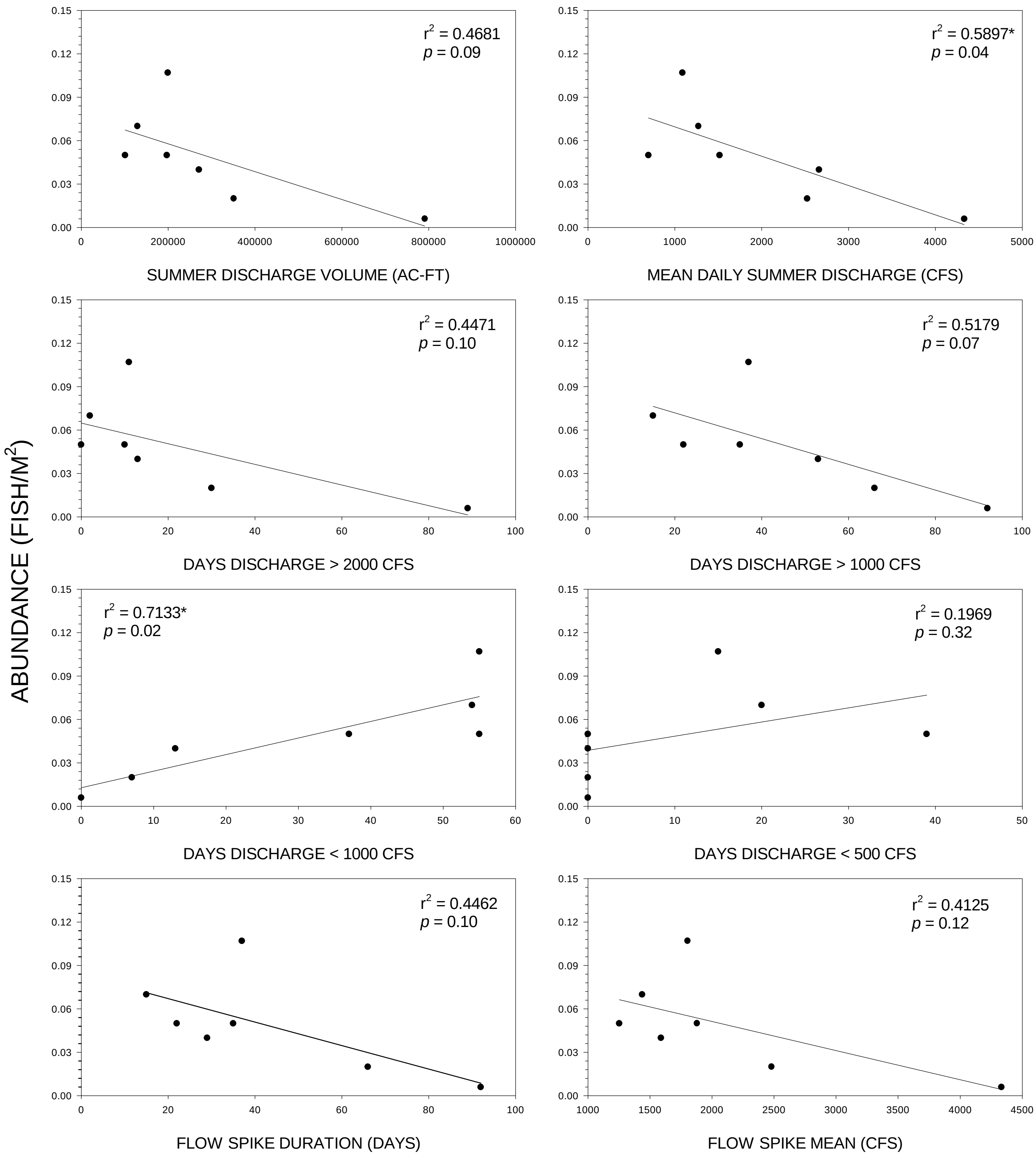

Figure 38. Relationship of channel catfish autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

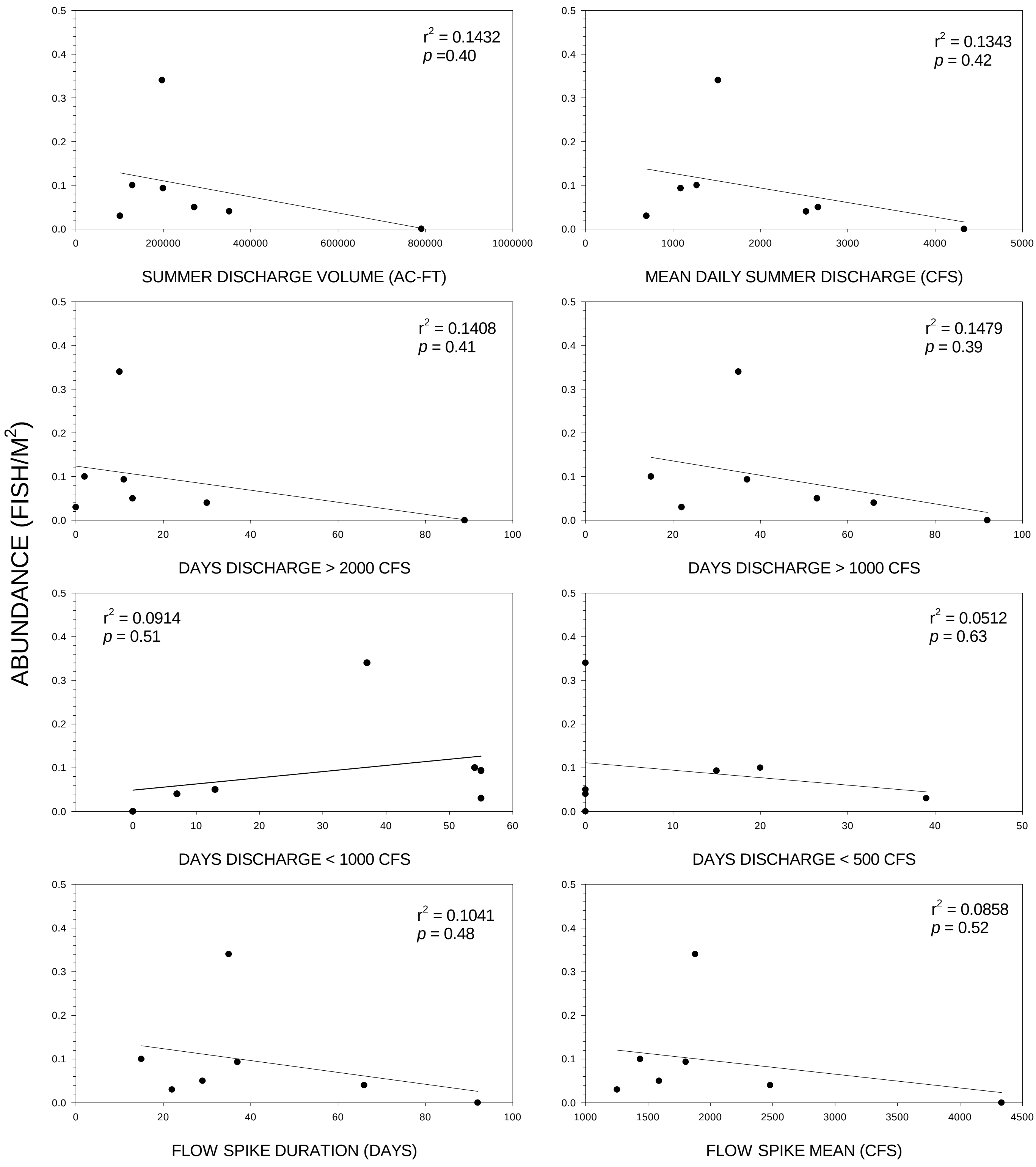

Figure 39. Relationship of channel catfish autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

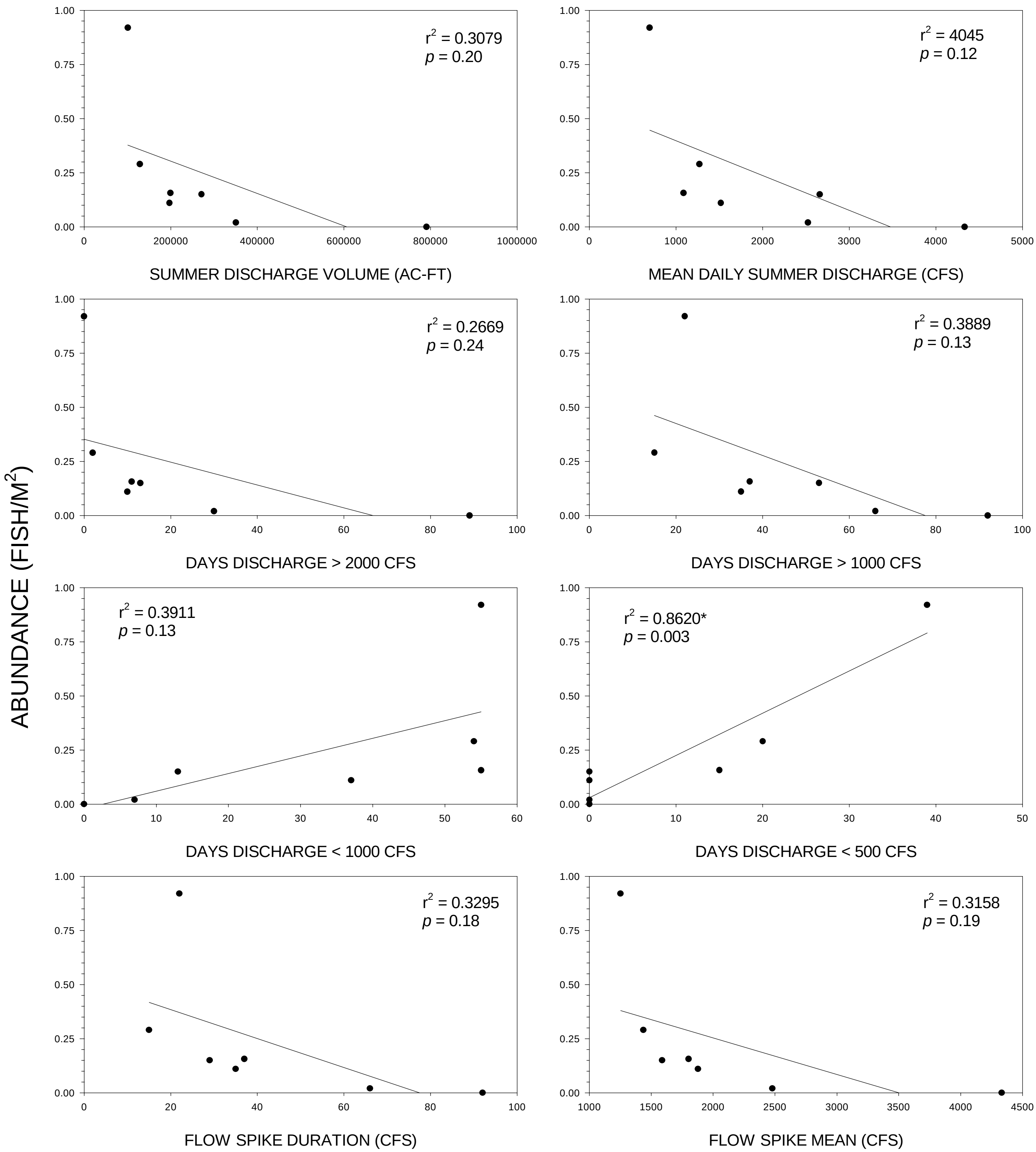

Figure 40. Relationship of western mosquitofish autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 5, San Juan River, 1993 - 1999.

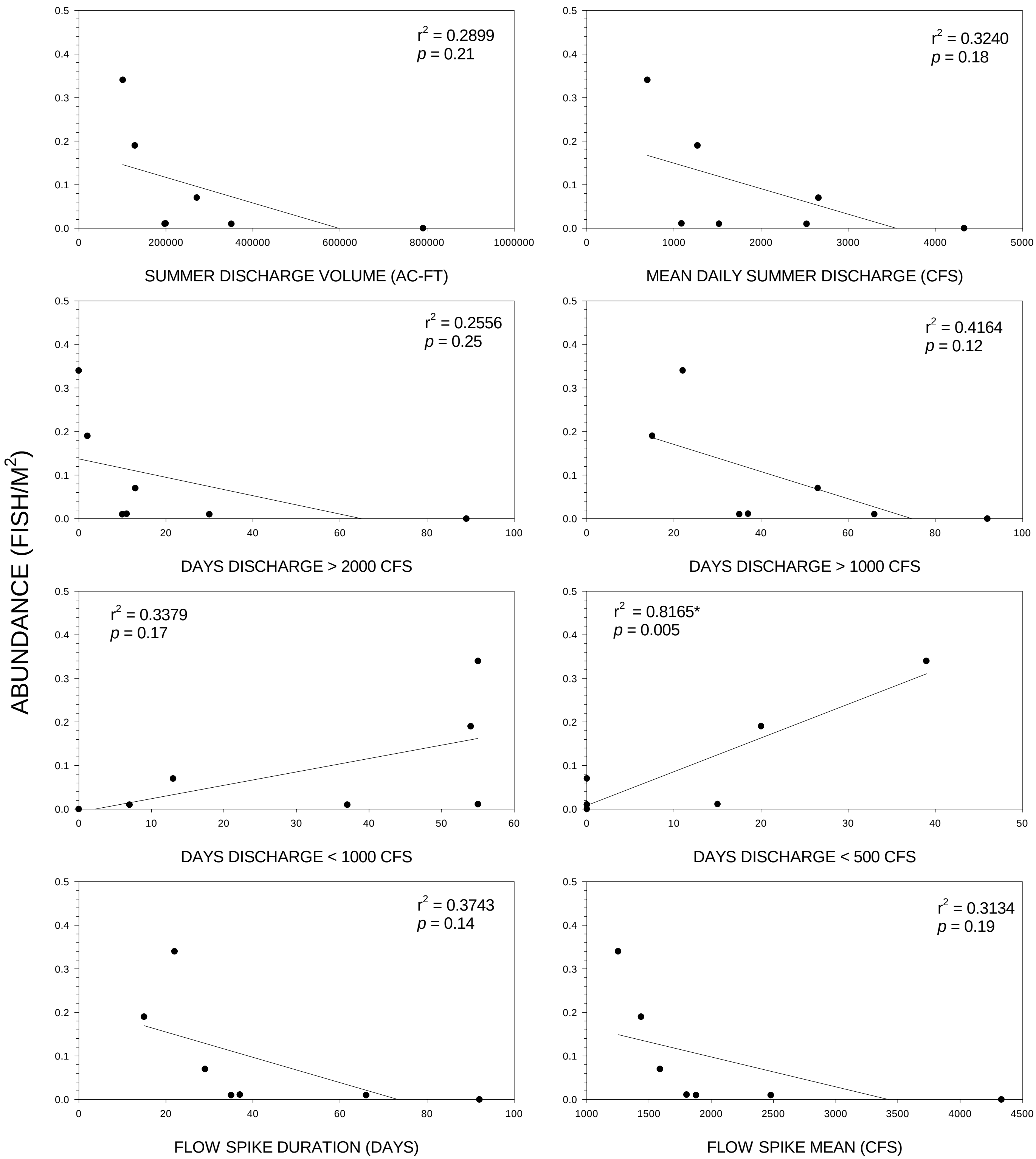

Figure 41. Relationship of western mosquitofish autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 4, San Juan River, 1993 - 1999.

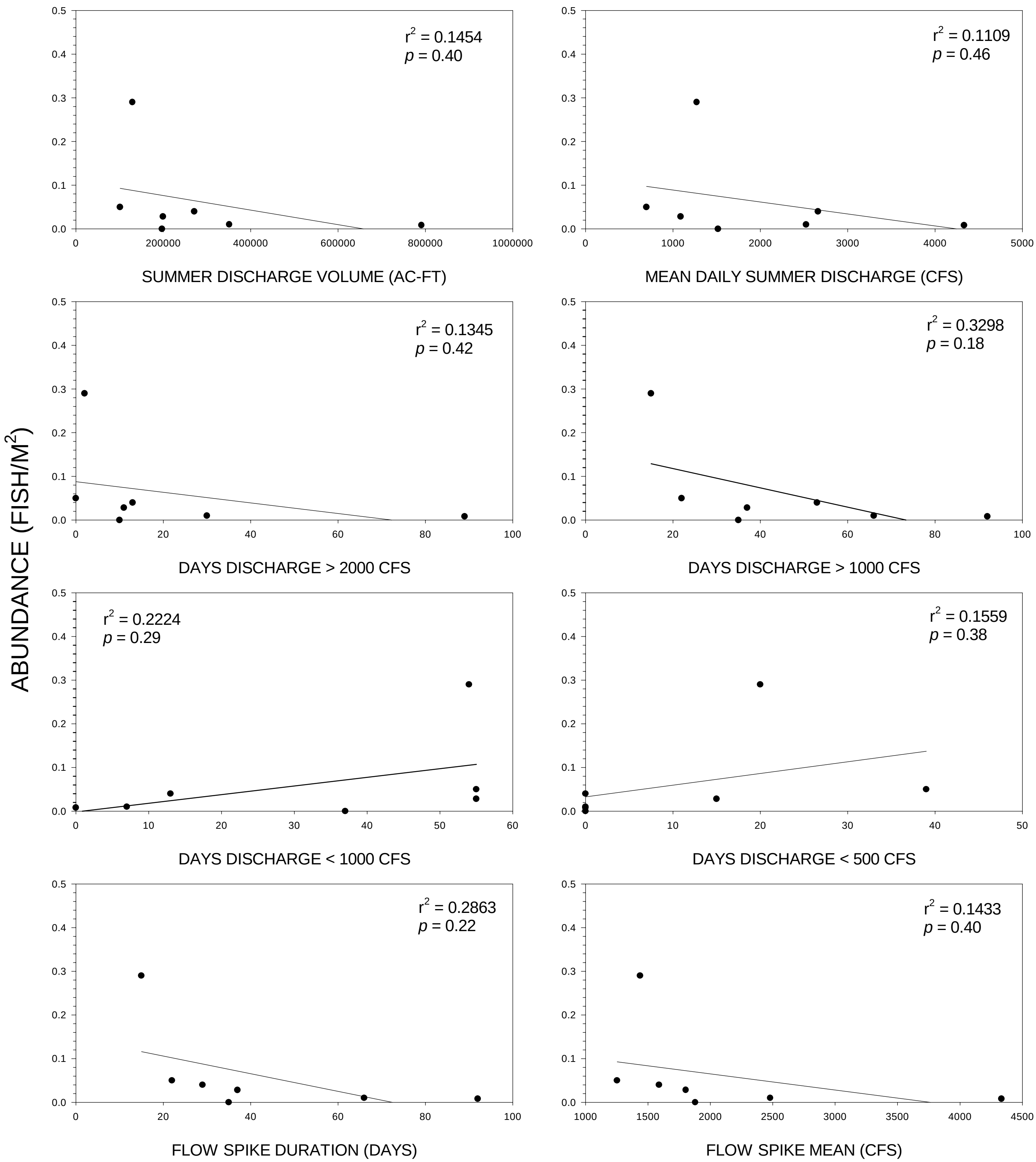

Figure 42. Relationship of western mosquitofish autumn abundance (fish/m^2) versus summer discharge attributes in Geomorphic Reach 3, San Juan River, 1993 - 1999.

SUMMARY

PRIMARY CHANNEL

1. Ten fish species (five native and five nonnative) were collected the primary channel during autumn surveys in 1998 and 1999.
2. Total abundance of small-bodied fishes was greater in 1998 than 1999.
3. Red shiner was the most abundant species in both years and speckled dace was second-most abundant.
4. Channel catfish was moderately common in 1998, but rare in 1999.
5. Colorado pikeminnow and roundtail chub were found in primary channel shoreline habitats in both years.

SECONDARY CHANNELS

1. Autumn abundance of fishes was less in 1999 in all reaches in any preceding year (1993-1998), but was only marginally less than found in 1997 and 1998.
2. Assemblage diversity did not change substantially from 1993 through 1999 in Reach 5, 4, or 3.
3. Fourteen fish species (five native and nine nonnnative) were collected in 1998 and eleven (six native and five nonnative) were collected in 1999.
4. Red shiner was the most abundant species in 1998 and 1999 in Reaches 5, 4, and 3, except Reach 3 in 1998 and Reach 5 in 1999 when speckled dace was most abundant.

5. Colorado pikeminnow was found in 1998 and 1999 in Reach 5.
6. Roundtail chub was found in 1998 and 1999 in Reach 4.
7. Autumn abundance of native speckled dace, flannelmouth sucker, and bluehead sucker was positively and significantly related to several attributes of spring discharge in Reaches 5 and 4. Relationships were positive, but not significant in Reach 3.
8. Autumn abundance of red shiner was not related to spring flow attributes in Reach 5, 4, or 3. Fathead minnow autumn abundance was negatively related to spring discharge volume in Reach 4, but there were no relationships in Reaches 5 and 3. There was no relationship between channel catfish abundance in Reaches 5 and 4, but there was a positive and significant relationship with days discharge > 5000 cfs in Reach 3. Autumn abundance of western mosquitofish was negatively related to spring runoff in Reaches 5 and 4, but not in Reach 3.
9. There was generally no relationship between autumn density of native fish species (speckled dace, flannelmouth sucker, and bluehead sucker) and summer discharge attributes.
10. Autumn abundance of nonnative fish species (red shiner, fathead minnow, channel catfish, and western mosquitofish) was generally negatively related to elevated summer discharge. Red shiner abundance was significantly (and negatively) related to flow spike duration in Reach 4. Fathead minnow abundance was significantly related to days discharge > 1000 cfs (negative) and days < 500 cfs (positive) in Reach 4. Channel catfish abundance was significantly related to mean summer discharge (negative) and days discharge < 1000 cfs

(positive) in Reach 4. Western mosquitofish abundance was significantly and positively related to days discharge < 500 cfs in Reaches 5 and 4.

LITERATURE CITED

Bliesner, R. and V. Lamarra. 2000. San Juan River habitat studies. San Juan River Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.

Propst, D.L. and A.L. Hobbes. 2000. Seasonal abundance, distribution, and population size-structure of fishes in San Juan River secondary channels, 1991 – 1997. San Juan River Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.

Propst, D.L., S.P. Platania, D.W. Ryden, and R.L. Bliesner. 2000. San Juan River Monitoring Plan and Protocols. San Juan River Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.